ROADS AND STREETS

PUBLISHED MONTHLY BY ENGINEERING AND CONTRACTING PUBLISHING COMPANY
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The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1.50 a year, and a quarterly at 50c

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Water Works—2nd Wednesday
General Contracting—3rd Wednesday
Buildings—4th Wednesday
Equipment Review—5th Wednesday
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Our Twentieth Anniversary

Twenty years ago "Engineering-Contracting" appeared as a monthly magazine devoted to contracting in the civil engineering field. Three months later it absorbed "Contract News" and became a weekly. About a year later "Engineering World," and shortly thereafter "The Dirt Mover" were absorbed. The merger of these four magazines led to a broadening of the scope and a change of name, the new name being "Engineering and Contracting."

Nine years ago, the weekly plan of publication was so modified that four monthly special issues were produced, each of which covered one branch of the construction field, which could be subscribed for as a monthly.

The latest step in this evolution is the segregation of these four monthly publications in name as well as in fact. They will continue to be published on successive Wednesdays, so that they will furnish a weekly service.

Roads and Streets, during its nine years, has grown greatly both in circulation and in advertising. Its circulation, including that of its free supplement, "Road and Street News," is 27,000 copies, of which one-third are paid subscribers.

The leading magazine of general circulation in the civil engineering field averages about 30,000 copies per issue; yet in the highway field alone "Roads and Streets" has attained almost as great a circulation. By the end of the present year, it is probable that "Roads and Streets" will reach 30,000 copies.

The growth in our advertising during the last eight years has been not less remarkable than the growth in circulation. The Road and Street monthly issues of Engineering and Contracting averaged 37 pages of advertising in 1917; whereas for 1925 the average was 126 pages.

In one of its first issues, twenty years ago, "Engineering-Contracting" espoused federal aid in road construction. The two leading weekly civil engineering periodicals and the then leading highway magazine opposed federal aid, and did not cease opposition until it had become a fact. It was our belief then, and still is, that federal aid should be given to the states in highway improvement, even as the states should aid the counties. Why draw political lines so rigidly that the locality in which a road is built must finance the entire cost of building? There never was a satisfactory answer to this question. We doubt whether there ever will be.

"Engineering-Contracting" at first called itself a "serial sequel to Gillette's Handbook of Cost Data," and its slogan was "Methods and Cost Articles." Here, too, it met with violent criticism from the two leading civil engineering weeklies. It was argued that cost data could be of use only to the men who gathered them. Our reply was that if so, the same argument could be urged against publishing almost any kind of data—strength data, for example. For more than a decade the publication of cost data has been generally adopted by other construction periodicals.

When the "world war" brought about a great rise in commodity prices, there was a prevalent belief that soon after the war ended prices would recede to the prewar level. This belief was so pronounced that much construction work was postponed in 1919 to 1921. The par-

tial price deflation in 1920 gave rise to an expectation of complete deflation.

In April, 1920, the editor wrote and published an article on price levels that embodied the results of his work and that of three assistants for more than three months, or the equivalent of one man's continuous work for a year. In that article a price level formula was deduced, and was shown to accord substantially with actual price levels for each of the 60 years preceding. The publicity that this formula received in the daily papers, and the discussions that followed, served in large measure, we believe, to dispel the illusion that prewar prices could be expected in the near future. Almost six years have elapsed since the price level formula was published, and every year has shown a price level in accord with the formula.

In 1921 a wage level formula was deduced and published by the editor. It accorded with wage levels for each of the preceding 80 years, and it has remained in accord with the level in each of the five years following its deduction.

It has long been our editorial policy to publish usable information derived from every source, foreign as well as domestic. We are not concerned whether it has appeared elsewhere before it appears in our columns. Our concern is whether it is likely to be of use to our readers. We are not editing a daily newspaper nor a story magazine. Neither a "scoop" nor the discovery of a new author interests us as editors. We seek usable facts and correct theories. Most of these of necessity must be secured from sources other than our personal efforts. But we have mentioned a few of our contributions to fact and theory to indicate that only a part of our editorial time is spent in the use of scissors and paste pot.

Yet we should not shrink from a defense of an editing policy that consists in nothing but the selecting of the best that has been printed elsewhere. The Literary Digest is an example of such editing. As a matter of fact, the best engineering books are little else than abstracts of matter that has appeared in the technical press. Why, then, is there such a world of difference between engineering books on the same subject? The difference is in the judgment of the authors and in the degree of energy used in searching for information. A lazy author with poor judgment produces a poor book. An energetic author with good judgment produces a good book. It is so with the editing of an engineering periodical. Indeed, does not the same hold true in every walk of life? Pitifully few and small are the facts that each of us gathers from his own little crabapple tree of personal experience. If knowledge is to be great it must be harvested from every orchard in the world.

Very few readers have the time to read many periodicals even in their own specialty, to say nothing of the subscription expense. It is our editorial plan to present practically all of the current, usable information relating to the construction and maintenance of roads and streets. In this respect we go far beyond the editorial plan of The Literary Digest which involves merely a digest or abstract, and does not cover but a small fraction of the news at that.

An average issue of "Roads and Streets" will contain 50 pages of articles, or the equivalent of a text book of 100 pages. In 12 such books it is feasible to present all the worth while yearly literary product relating to highways. This is our editorial aim.

Unjustified Criticisms of the Increase in Local Taxes

The census bureau has recently published statistics showing that the 48 states averaged a $9 per capita expenditure for "routine expenses" for the year ending June 30, 1924, as compared with $4.19 in 1917, is an increase of 115 per cent. This has been made the subject of many an editorial comment on the growing extravagance of state government. It should be noted that practically the entire increase in wage rates occurred in that seven year period, and that the general average of industrial wages more than doubled. Hence a per capita increase of 115 per cent in state "routine expense" is mostly attributable to wage increases, and is not itself an evidence of extravagance in state administraiton.

Certain federal officials have been conducting a campaign of criticism of state, county and city governments, claiming that these local governments should pattern after the federal government in reducing taxes. But those same officials have never called attention to such facts as the following: The total of state, county and city taxes increased only 100 per cent during the 11-year period that federal taxes increased 340 per cent, mainly the period between the years 1912 and 1923. Since the war accounted for this disproportionate increase in federal taxes, it follows that each year following the close of the war it has been possible to show a pronounced reduction in federal expenses. The same has not been possible in the case of local taxes. In fact, the normal tendency of local taxes is to rise, not because of reduced efficiency of local governments, but mainly because local governments are called upon to conduct their functions more effectively. Take, for example, our schools. The states that have the highest per capita expense for schools are certainly not to be held up to criticism, but are rather to be praised for their far sightedness. No

other item of local government expenditure equals the expenditure for education. Shall we curtail local expenditures for education? The question answers itself.

Even the increase in bond issues for roads has been criticised, in face of the fact that the expenditure for road vehicles increases faster every year than the expenditure for road improvement. There are more than 20,000,000 motor vehicles in use in America, almost one for every family. Does not the very act of buying a motor car constitute a vote for further improvement in our highways? If so, nearly every family in America has already cast a vote in favor of better highways and therefore in favor of highway bond issues.

Road Improvement Not Keeping Pace with Transportation Needs

Four years ago there were in America 390,000 miles of "surfaced rural roads," that is roads surfaced with gravel, sand, clay, macadam, or some form of pavement. The total mileage of roads in America was almost 3,000,000, so that about 13 per cent were "surfaced." Since 1921 surfaced mileage has been built at the rate of 30,000 to 40,000 miles annually, but an undetermined part of this consisted in resurfacing. It is probable, therefore, that not much more than 15 per cent of our total road mileage is surfaced. (Since this was written a statement has been published that 15.5 per cent of all our roads are surfaced.) Since a very large part of this surfaced is merely a cheap temporary surfacing, it will be seen that we have hardly made a good start at road building.

One of the Mississippi Valley states will have surfaced about 40 per cent of its mileage by the end of 1926. But since the country as a whole has been adding to its surfaced highways at the rate less than one per cent annually during the past five years, it will be a quarter of a century before 40 per cent of the total mileage in America is surfaced. This is so pitifully slow a progress as to be discouraging. Incidentally it is a complete refutation of the oft repeated statement that road building has become an extravagance.

A billion and a quarter dollars a year sounds like a huge sum for annual road construction, until we learn that three times that sum is annually spent for new automobiles, not to mention the cost of operating automobiles. The annual cost of operating the 20,000,000 motor vehicles plus the cost of purchasing new vehicles probably is more than six times the total sum spent annually on our highways. In any event, it is clear that highway improvement continues to lag far beyond the economic needs—if motor cars are to be regarded as desirable investments.

The congestion of many streets and of the main rural highways near cities has reached such a pass that many motorists have ceased riding for pleasure on holidays and Sundays. Wider streets and wider roads, or more of them, are urgently called for in and near the large cities.

Rural districts are in sore need of more surfaced highways, as is indicated by such items as the following abstract from a Chicago daily paper:

"The end-of-the-week slump in gasoline prices was seen in the oil trade yesterday as a reflection in the poor demand from dealers over a large portion of the country. This slack demand is being caused by a reduced consumption due to unfavorable road conditions. In large areas in Missouri and Iowa roads are reported nearly impassable. Jobbers who ordinarily would sell several tank cars of gasoline a week are admitting their inability to take from refiners and brokers their normal shipments of gasoline.

"Rural roads are a factor in the gasoline business each year, and continue so this year despite the fact that there has been little weather of an extreme nature, and regardless of the gradual increase in hard road mileage."

Highways in Forest Reservations

The forest highway systems, according to the annual report of the U. S. Bureau of Public Roads for the fiscal year June 30, 1925, have been definitely selected and approved by the Secretary of Agriculture in all states, except Oregon and New Mexico, and all funds available for forest-highway improvement are being expended only on the approved systems. In Oregon and New Mexico, approval of projects is being limited to the systems recommended by the Bureau of Public Roads pending final agreement of the cooperating agencies on systems which can be approved by the Secretary. The total mileage of the approved systems, including the mileage in the recommended Oregon and New Mexico systems, is 13,396 miles. Of this total, 1,043 miles are class 1 highways, i. e., roads which are necessary sections or extensions of the Federal-aid system wholly within the national forests. Class 2 roads, which are extensions of the Federal-aid system and partly within or adjacent to and serving the national forests, have a total length of 6,904 miles; and class 3 roads, which are roads of primary importance to counties or communities within the forests, have a total length of 5,449 miles. Of the total mileage selected, 4,011 miles or approximately 30 per cent are necessary sections of the Federal-aid highway system.

Bank Protection

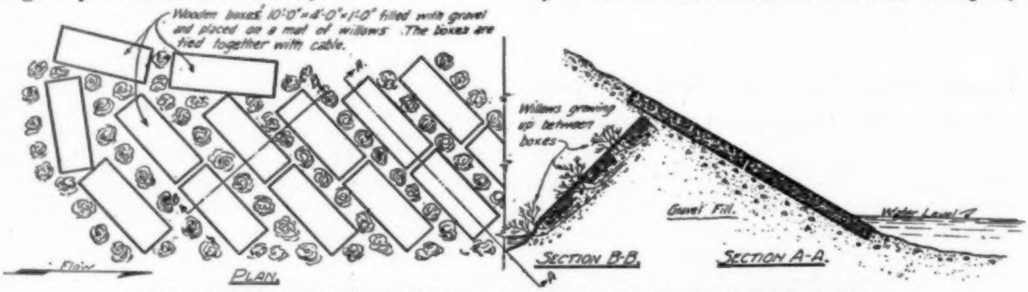
New Type Used by California Highway Department Described in November California Highways

By L. D. PACKARD
Of California State Highway Bridge Department

A new plan for protecting banks, a departure from the usual type of willow protection work, is being tried by the Bridge Department at the approach fill at the south abutment of the Van Duzen River bridge, on the Redwood highway in Humboldt County.

As necessary materials were readily available, the plan proved economical. The total cost was $247 for 25 boxes, or $9.88 per box installed. The protection was placed during March of this year. Despite two rises of the river since that time, the willows, on Sept. 1st, showed a growth of about 2 ft. in height. By the time the next highway water occurs, they should be well rooted.

It was at the suggestion of Commissioner Louis Everding that this type of protection was used. He has been familiar with its effectiveness along Mad River, Humboldt County, where the plan has been followed for six years by the Northern California Redwood Company.



Sketch Showing Details of Method of Constructing and Placing Bank Protection

Timber boxes 1 ft. x 4 ft. x 10 ft., constructed from 2 in. material, were placed on top of a mat of willows. The boxes are designed to prevent the willows from being washed away before they have grown to sufficient size to withstand destructive action of flood waters.

The boxes were set at a 45° angle to the flow of the stream and at an angle of 15° to 20° to the stream surface. When placed in this manner, they cause silt to be deposited on the young trees, materially aiding their growth. To prevent the boxes from being washed away, they were filled with coarse gravel, fastened together with cables, and anchored to the bridge abutment.

The willows, when planted, were placed with the small ends pointing up stream. Cuttings of not to exceed 1 in. in diameter were used. The results so far, the bridge department believes, justify the recommendation of the commissioner.

Road and Street Contracts Awarded During the Last 71 Months

The accompanying table, compiled from statistics in the Engineering News Record, shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923	1924	1925
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000	$ 16,972,000	$ 22,720,000
February	21,334,000	12,049,000	9,052,000	18,781,000	19,214,000	20,104,000
March	26,221,000	25,880,000	39,669,000	37,706,000	41,395,000	25,910,000
April	33,340,000	31,026,000	32,991,000	29,641,000	43,513,000	60,8[illegible]1,000
May	30,258,000	35,064,000	42,284,000	46,528,000	65,354,000	5[illegible],418,000
June	31,441,000	56,777,000	42,138,000	38,040,000	44,494,000	42,451,000
July	29,353,000	33,943,000	26,087,000	42,397,000	45,784,000	45,246,000
August	18,565,000	28,693,000	37,035,000	35,639,000	40,536,000	41,199,000
September	26,537,000	23,257,000	28,884,000	37,812,000	44,585,000	36,949,000
October	12,894,000	20,055,000	23,162,000	28,144,000	35,198,000	31,416,000
November	12,443,000	20,751,000	20,892,000	23,683,000	18,382,000	23,492,000
December	10,834,000	16,263,000	18,096,000	21,035,000	14,894,000	....
Total	$265,424,000	$315,356,000	$334,741,000	$381,097,000	$430,281,000	....

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

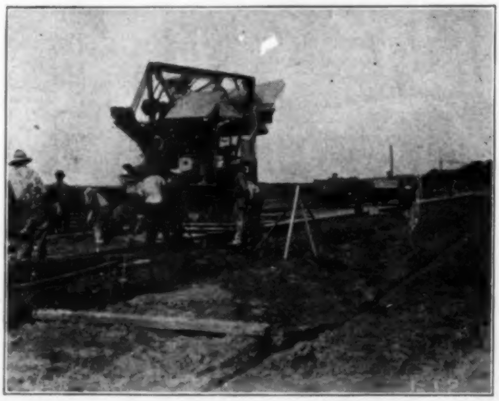
Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

Trucking Within the Construction Lines of a Road Job

Practical Suggestions for Securing Rapid Truck Movements: Location of the Machinery and Equipment—Subgrading Operations—Roadways Outside of Forms—The Turntable—The Dumpman at the Mixer—Planking Soft Subgrade—Stalled Trucks

By L. T. SOGARD
With The Henkel Construction Co., Mason City, Ia.

The rate at which concrete pavement can be laid is dependent upon two principal factors: equipment and organization. One of the vital and important phases of organization in paving operations, where the batched materials are conveyed to the mixer by trucks, is the rate at which the trucks can travel while within the construction lines. With the amount of equipment necessary for rapid and economical progress in paving, this problem becomes quite involved and the foreman in charge of construction must exercise much forethought and often use his ingenuity in keeping a road cleared for the trucks. Certain items rapidly become routine, but each day, as the forms reach out ahead, new problems arise and new solutions are necessary.



General View Showing Paving Operations of Henkel Construction Co.'s Truck Outfit on DeKalb County, Illinois, Job.

Location of Machinery and Equipment.—The machinery of a paving outfit which is used in advance of the mixer includes a subgrader of some sort and a roller. A well equipped outfit may have a form digging machine; two rollers, a large steam roller for scarifying and compacting and for pulling a subgrader which rides on the forms, and a light gas-engined roller for the final rolling of the finished subgrade; a tool wagon; and a turntable for the trucks. Obviously with so many machines, plus a team or two hauling forms, the possibility for confusion with its concomitant loss of time, is great. Good management keeps this loss at a minimum.

The first problem is the lining up of the machinery while not in use. Both rollers and the subgrader should be on one side of the road, crowded as close to the form-line as convenient and as close in file as possible. This makes one bottle-neck instead of three and eliminates the weaving and winding of the trucks about the machinery and also leaves a clearer view of the roadway for the drivers. The tool-wagon should be kept outside of the form-lines and far enough ahead to obviate any interference with the teaming. Teaming behind the mixer has to be done outside of the forms and therefore can be so done ahead of the mixer. The tendency to team within the lines ahead is likely because generally it affords a smoother roadway; but obviously much congestion can be avoided by working outside.

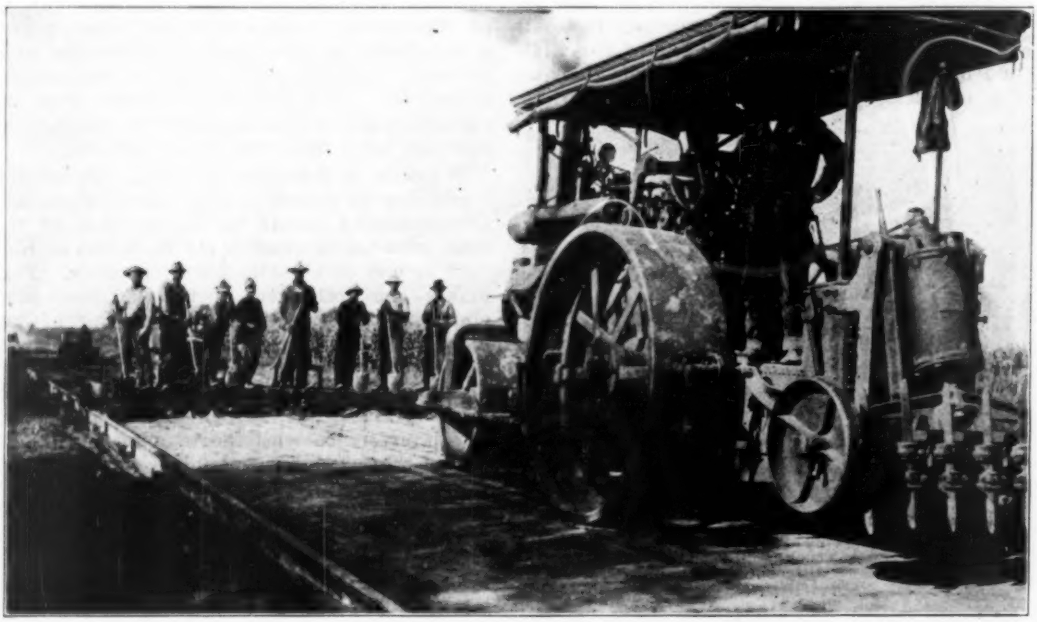
An 18-ft. roadway is quite a narrow path for two streams of moving trucks and anything left within the form-lines lessens that roadway in proportion to its size. This con-

Truck Dumping Batch Into Mixer Skip.

dition creates bottle-necks, or narrow roadways, which slacken truck movements. One of the worst of these is the stringing of the forms within the wire form-lines, as the forms are brought up from the rear for re-setting. Fully $1\frac{1}{2}$ ft. of roadway are occupied on each side by these unset forms, which narrows the roadway to 15 ft. for a distance of several hundred feet. The result can be imagined.

The Mechanical Form-Digger.—A form digging machine has been recently placed on the market and its labor-saving ability was readily recognized by contractors. One disadvantage of this machine for a truck outfit, however, is the fact that the screw dirt-conveyor is so placed that the windrows of dirt, which it leaves, are inside the form-lines. When the cut is deep, these windrows on each side occupy a considerable portion of the roadway and thus narrow the truck passageway. Disposition of this dirt should be made as soon as practical. An inspection of the engineer's form-stakes will tell the foreman whether this dirt must remain within the form-lines or be wasted on the outside. If it is to remain within, a small team-drawn blade can be used to level the windrows. If the dirt is to go outside, it can be taken out in a short time with a slip or small fresno. Often inspection will show that the dirt in the windrows must go outside the lines but that the small amount does not warrant the use of slip or fresno. In this case it is more economical to spread it over the roadway, between the lines, and remove it during the final preparation of the subgrade, than to leave it untouched in the windrows, an obstacle to the trucks.

Subgrading Operations.—To pave continuously at a rate of from 700 to 800 ft. per day requires considerable effort in the final preparation of the subgrade. With a truck-outfit, this work is often delayed by the truck traffic. The delay should fall upon the subgrading operations, however, and not upon the trucking, because of the axiomatic truth that without materials the mixer cannot pave. Here the foreman must "use his head." If a subgrader which travels on top of the forms is used, the length of each pull must be made with consideration to the number of trucks in view down the road, the number of trucks at the mixer, and the amount of cutting to be done, as evidenced by the windrows piling up behind the subgrader.



Cutting Subgrade to Correct Elevation on Henkel Construction Co. Job.

Roadways Outside of Forms.—Occasionally conditions are such that, with a little work with a blade, a fairly good roadway can be prepared outside of the forms. The empty trucks can then be routed around the stretch of grade being prepared. The resulting one-way traffic through the subgrading crew facilitates its operations more than one might realize off-hand. The men expect the trucks from only one direction and are unconsciously more mentally at ease. The trucks can follow one path and do not have to cross and re-cross

the windrows of dirt left by the subgrader. This makes the removal of these windrows more easy. Longer and fewer pulls with the subgrader can be made without delaying the trucks, for naturally no loss of time results in the holding up of several loads if there are trucks waiting at the mixer and the empties have a means of egress. Sometimes, when a suitable truckway can be found, both empty and loaded trucks can be diverted outside the forms. This often proves valuable where the subgrading work is extremely difficult due to softness, excess cut, dust, etc.

The Turntable.—Economy in time and truck-repairs result when a turntable is used to reverse the trucks at the mixer. That it saves more than its cost is beyond doubt, but to save the maximum time possible requires intelligent moving and spotting of the table. When the number of trucks is such that there is not a truck ready to back into the mixer-skip each time it is lowered, the turntable should not be more than 50 ft. ahead of the skip. This leaves but a short distance for each truck to back and a saving of time is thereby effected. On long hauls the trucks have a tendency to bunch more than on shorter hauls. This is due to several factors, in part to the performance of the truck and the personal equation and skill of the driver. When the trucks tend to appear at the mixer in droves, the turntable can be set well ahead of the mixer so that two or three trucks can be waiting between the turntable and the mixer.

When the turntable is moved, it is generally towed by an empty truck. A time is picked preferably when no trucks are in sight ahead. After the last truck has backed off the table, the first empty is conscripted and the turntable moved ahead. The move can generally be made with very little delay to the loaded trucks, and often with no delay when the turntable operator becomes familiar with the idiosyncracies of the truck movements.

The Dumpman at the Mixer.—The dumpman, at the mixer skip, is responsible, in a large measure, for time-economy after the trucks are off the turntable. By signalling the drivers when to back into the skip, and stopping them in the correct position for dumping, he helps the driver and thus saves time. He can also keep at a minimum the spilling of the batch over the skip-lip which necessitates shovelling the spilled materials back into the skip and loses time. A good dumpman will get the empties away as soon as they are dumped, not even permitting the driver to replace the lock-pin (common to several types of dump bodies), until the truck is entirely clear of the skip and the mixer operator free to hoist the skip.

Planking Soft Subgrade.—Trucking over a muddy subgrade is slow and expensive, but it is often necessary. Soft spots can be passed over much more easily, and with less rutting

Removing Windrows of Dirt Left By Subgrader

and cutting of the grade, if they are planked. It has been found that planking-units 10 ft. long and 2 ft. wide are most convenient and are easily handled. These units are built of two 1 in. x 12 in. pieces, 10 ft. in length, laid side by side, and fastened together with 1 in. x 12 in. cross-pieces, 2 ft. long, spaced about ½ to ¾ in. apart. The resulting unit has some flexibility and the spaced cross-pieces provide a suitable resistance for slippery tires. These planking-units are placed end-to-end in two rows, at the proper distance apart, to provide two wheelways.

Speeding over the planking is a certain loss of time. The units soon lose their alignment and it requires but one truck off the boards and into the mud to tie up things for a period of from 5 to 15 minutes. Backing on planking is slow work, but it can be done if the drivers will proceed with caution. It should be avoided whenever possible because of its difficulties and the probability of getting off the boards into the mud.

Stalled Trucks.—One more factor in the slowing up and even stopping of truck-movements is the truck which stalls near the mixer. The quickest way out of the tangle, which is sure to result, is to draft every workman within hailing distance and shove the derelict into the skip, dump it, and push it down the road beyond the turntable. Often, if thrown into gear while in motion, the dead engine can be revivified.

Conclusion.—The main business all along the line, from plant to mixer, is to keep the trucks moving. No money is made in the paving game while the mixer is stopped. An economical plant set-up is vitally important, proper maintenance of the intervening road is essential, but neither are any more important or at all as difficult as rapid truck movements within the lines of construction. To this end the road foreman must devote a large part of his time if he is to keep up his end of the job.

Highway Construction in Cuba

The Public Works Law of 1925, provided for the construction of a Central Highway the length of the Island, and certain road and street paving projects in each province. A "Special Fund for Public Works" is provided for in the law, to be derived from tax receipts. After 10 years, only the transportation and gasoline taxes will remain in effect. A survey of parts of the Central Highway has been completed, and the Government has appropriated $300,000 to be divided among the six provinces for repairing existing roads. Plans are now complete for the new construction program, but it is expected that the Government will call for bids in January.

Economic Theory of Highway Improvement

Summary of Committee Report Presented at Fifth Annual Meeting of Highway Research Board

By Chairman T. R. AGG
Professor Highway Engineering, Iowa State College

Relation of Tire Tread Wear to Type and Condition of Road Surface.—The investigations on this subject show the following preliminary results:

Tire Wear Indices for Various Road Surfaces

Road Surface	Index Number
P. C. concrete	1.00
Monolithic brick	1.01
Bituminous filled brick	1.00
Iowa gravel	2.20
Chert gravel	7.30
Bituminous macadam without seal coat	10.60

Other investigations show that the rate of tire wear on macadam is 17 times as great as on concrete, and may be 56 times as great on poor macadam.

Intensity of Downward Kick of Rear Wheels of Vehicles Starting from Rest.—Theoretical analysis and experiments with twelve vehicles tend to show that the intensity of the downward kick ranges from 100 lb. to as much as 1,000 lb.

Wind Resistance of Motor Vehicles.—The intensity of wind resistance, determined by wind-tunnel measurements, appears to follow closely the law: $Rw = .0025AV^2$; where Rw is the total wind resistance in pounds; A the projected cross section area of the vehicle in square feet; and V the velocity in miles per hour of the air with respect to the vehicle.

Relative Wear and Tear Upon Highways Produced by Light and Heavy Trucks.—The complete report presents data covering a wide variety of vehicles operated under diverse conditions.

Tractive Resistance.—Experiments show that the sum of rolling plus air resistance is correctly expressed as: $Rt = Rr + Rw$; where Rt is the sum of rolling plus air resistance; Rr the rolling resistance for the particular type of tire and road; and Rw the air resistance.

A large number of determinations of values for Rr show that it varies from 20 to 30 lb. per ton for good surfaces, and may be as high as 100 lb. per ton on inferior surfaces.

Riding qualities of road surfaces, rolling resistance and gasoline consumption on typical highways are being studied, but these projects are not in the stage where results are available.

Repair and Maintenance of Old Water Bound Macadam Streets

Methods and Costs of Resurfacing, Surface Treatment, Street Patrol Maintenance and Making Patches at Rockford, Ill., Given in Paper Presented October 22 at Fourth Asphalt Paving Conference

By B. C. HARVEY
City Engineer, Rockford, Illinois

There are still many cities in the country in which a large proportion of the paving is water-bound macadam. The maintenance of streets of this type offers a big problem to street departments because of the ever-increasing motor traffic and the heavier transportation units. The city of Rockford has aimed to organize its maintenance and repair work in such a way as to minimize the necessary expense and to keep the streets in first-rate condition. A very careful cost system is maintained, so that as nearly as possible the exact cost for each piece of work is known.

How Streets Are Paved.—There are 216.119 miles of streets, of which 139.729 miles are improved and 76.39 are unimproved. The improved streets are composed of the following types of pavement:

	Miles
Brick	20.414
Concrete	18.716
Resurfaced	13 505
Warrenite	5.581
Asphalt	1.85
Water-bound Macadam	57.951
Bituminous Macadam	21.712

Repair and Maintenance Equipment.—The city of Rockford owns and operates the following equipment for repairs and maintenance:

Two 12-ton Kelly-Springfield road rollers with steam scarifier attachment
One 3½-ton G. M. C. truck
One 3½-ton Master truck
One 3½-ton Republic truck
One 3½-ton Diamond T truck
One 2-ton Republic truck
One 2-ton Master truck
One 5-ton Holt Caterpillar tractor
One original design stone spreader
Two 2-ton Republic trucks with trailers equipped for street patrol work
One portable air-compressor, together with a very modern quarry and stone-crushing plant equipped to manufacture from 20,000 to 50,000 cu. yds. of stone yearly.

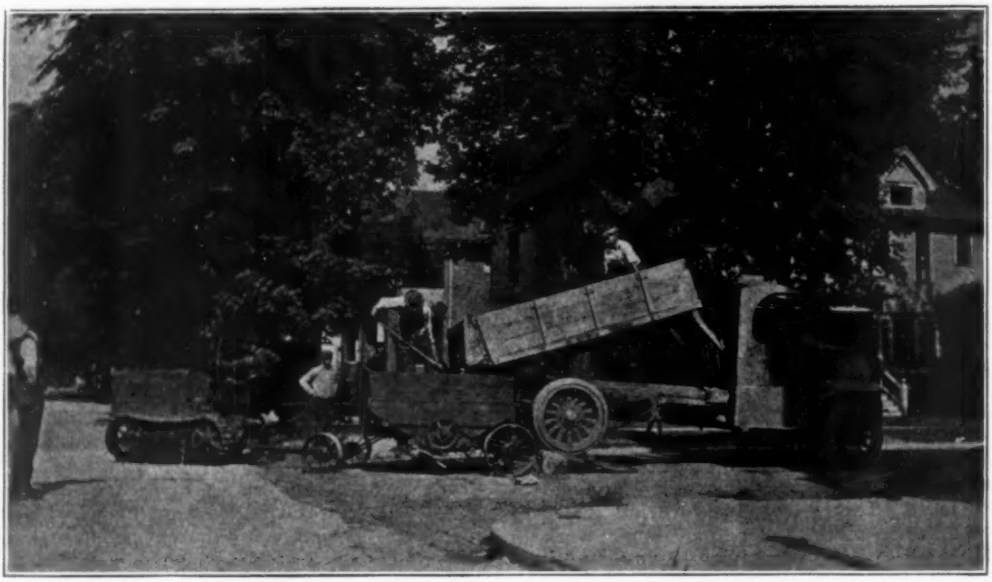
Organization.—The department is 100 per cent motorized, and skilled mechanics are engaged to operate the equipment. The average age of the men employed in the department is 40, which is low for a municipal organization. There is one superintendent of streets, one street foreman on resurfacing work, one street foreman on oiling (this man being a tractor-operator), one master mechanic who is responsible for the equipment and one quarry superintendent.

The Quarry.—The city owns and operates a quarry. The stone which is crushed at the quarry is a very hard, durable limestone. The crusher jaws are set to give four different grades of material: No. 0 material, which is dust; No. 1 material, ranging from ¼ to ½ in. stone; No. 2 stone, which ranges from ½ to 1¼ in.; and No. 4, which ranges from 1¼ to 2½ in.

Scarifying an Old Water Bound Macadam Street

Resurfacing of Old Macadam Streets Using Double Seal Method.—The old water-bound macadam streets which are beyond repairing by the surface treating method are scarified to a depth sufficient to either raise or lower the crown and quarterpoints of the streets. The loosened base is then graded and thoroughly rolled, leaving a smooth and firm base. Stone ranging from 1¼ in. to 2½ in. is spread over the area to a depth of 3 in. This stone is then rolled and compacted enough to allow a heavy truck to drive over it without causing deep ruts.

Bituminous material heated to a temperature ranging from 300 to 325° F., using 110 penetration asphalt, is applied at the rate of not less than 1½ gal. nor more than 1.8 gal. per

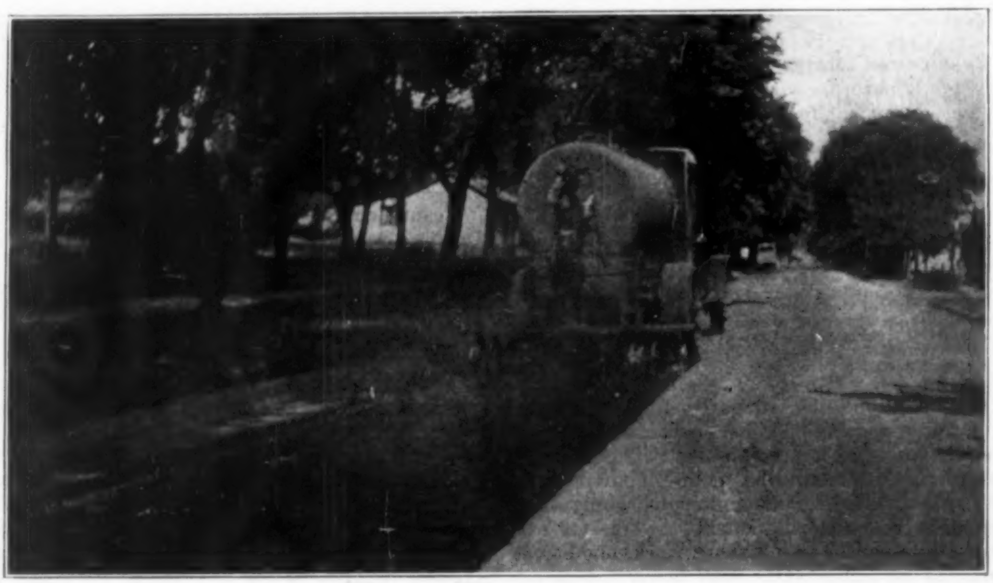


Loading the Stone Spreader

square yard. No. 2 stone, or stone ranging in size from ½ in. to 1¼ in. is then spread uniformly over the whole surface, filling all voids.

This course is then thoroughly rolled, leaving a firm, uniform surface. The roadway is then swept free from all loose particles of stone not held by the bituminous material. Then, not less than ½ gal. nor more than ¾ gal. per square yard of the same kind of bituminous material is applied, heated to the above described temperature. No. 1 stone, or stone ranging from ¼ in. to ½ in. in size is then uniformly spread over the surface.

The roadway is then thoroughly rolled again. Then the same kind of bituminous material heated to the same temperature as before specified is applied at a rate of not less than ¼ gal. nor more than ½ gal. per square yard.



Applying Bituminous Material

Small gravel, known as pea gravel is then uniformly spread over the surface. The surface is then rolled again until the bituminous material has a tendency to show through the gravel. This method has been found very successful, and after a few months of travel the streets look very similar to sheet asphalt pavement.

Cost of Resurfacing.—During 1924, 2.276 miles of streets were resurfaced, as described above and at a cost shown in detail below:

		Per sq. yd.
Rolling and scarifying 1,060 hours at $1.50 per hour	$ 1,590.00	$0.039
Grading roadway after being scarified, 64 hours at $2.00 per hour	128.00	.003
Labor for spreading stone and building up subgrade, 3,132½ hours	1,900.21	.046
Stone—6,806½ cu. yds. of crushed stone, delivered to job at $1.75 per cubic yard	11,911.38	.291
Gravel—73½ yds. pea gravel delivered to job at $2.00 per yard	147.00	.004
Asphalt—106,147 gals. of 110 penetration asphalt applied at 11.5 ct. per gallon	12,206.92	.297
Road oil—5,000 gals. of 45 per cent asphalt applied at 10.7 ct. per gal.	535.00	.013
Total Cost	$28,418.51	$0.693

Number of square yards resurfaced was 40,995.
Cost per square yard was $0.693.
The average number of gallons of asphalt used per square yard was 2.71 gals.
The bid price on 110 penetration asphalt was 10.98 ct. applied, and the bid price on road oil was 10.65 ct. applied.

During 1925, .653 miles of streets were resurfaced, as described above and at cost shown in detail below:

		Per sq. yd.
Rolling and scarifying 270 hours at $1.50 per hour	$ 405.00	$0.036
Grading roadway after being scarified, 61½ hours at $2.00 per hour	123.00	.010
Stone loader—22 hours loading stone and dirt	58.30	.005
Truck Service—77 hours, hauling dirt at $1.50 per hour	115.50	.010
Labor loading dirt—78½ hours	49.47	.004
Gravel—52¾ yds. pea gravel delivered to job at $2.00 per yard	105.50	.010
Stone—1,322.22 cu. yds. of crushed stone delivered to job at $1.60 per cubic yard	2,115.56	.187
Labor for spreading stone and building subgrade, 985 hours	631.95	.056
Asphalt—27,615 gals. of 110 penetration asphalt applied at 10 ct. per gallon	2,761.50	.245
Total Cost	$ 6,365.78	$0.563

Number of square yards resurfaced was 11,289.
Cost per square yard was $0.563.
The average number of gallons of asphalt used per square yard was 2.44 gals.
The bid price on 110 penetration asphalt was 18.90 per ton F. O. B. Rockford.

In the costs as recorded above, interest on the investment of equipment together with the depreciation on the equipment is included. In the cost of the asphalt, car demurrage and cost of steam and clerical work are included.

Surface Treatment of Macadam Streets.—The surface-treating or oiling crew is composed of the superintendent of streets, who acts as supervisor, one foreman, who is also the tractor operator, two laborers, and four truck operators. The equipment consists of one 5-ton Holt Tractor, one stone spreader, designed by the writer and made by the street department, and generally four trucks, though on some occasions only three trucks are necessary, depending on the length of haul. Two of the trucks are owned by the city of Rockford, and the other trucks are hired from the company from which material is purchased, based on cost per yard delivered.

When macadam streets are to be surface treated, they are first thoroughly swept. The method of cleaning consists in sweeping the surface with two motor-driven Elgin pick-up sweepers. Two one-ton Ford trucks are used for hauling the sweepings to the dump. The two truck operators and two laborers clean all places not accessible to the sweeper and shovel all rubbish into the trucks and haul it to the dump. The cost of cleaning is charged against the street-cleaning fund. The average cost per 1,000 sq. yds. for cleaning all streets during 1924 was 41.48 ct. During the year 1925 up to Sept. 1st, there have been cleaned 29,037,129 sq. yds. at a total cost of $11,615.95 or 40 ct. per 1,000 sq. yds.

The bituminous material is applied at a rate depending upon the condition of the surface of the roadway. The average rate of application during 1924 was approximately 0.15 gal. per square yard, and in 1925 the average rate of application was 0.22 gal. per square yard. Finely graded gravel, known as pea gravel, is then uniformly spread over the surface of the roadway by the stone spreader, which operates uniformly to a width of eight feet. The stone spreader is drawn by the 5-ton Holt tractor. The two laborers assist with loading the stone spreader and scatter extra gravel whenever necessary. The gravel is dumped directly into the stone spreader. We have surface treated as much as 27,232 sq. yd. of pavement in one 8-hour day.

Cost of Surface Treatment.—During 1924 a total of 61.647 miles of macadam streets was surface treated, making a total of 1,113,826 sq. yd. The total cost for this work was $25,258.41 or a cost of $0.02267 per square yard. The cost of cleaning streets prior to surface treating is not included in this cost. The cost of surface treating is figured as follows:

OILING OF STREETS

Oiling with Road Oil—Year 1924

Miles of streets oiled	0.534
Gallons of oil used—2,425 gals. @ 10.7 ct. per gal.	$ 259.48
Number of square yards oiled	7.724
Cost per square yard	0.0335

Oiling with 4-B Asphalt—Year 1924

Miles of streets oiled	0.253
Gallons of asphalt used—1,300 gals. @ 11.5 ct. per gallon	$ 149.50
Yards of sand—9 yds. @ $1.00 per yard	9.00
2 yds. of pea gravel @ $2.00 per yard	4.00
Labor spreading sand and gravel	18 60
Total Cost	$ 181.10
Number of square yards oiled	3,201
Cost per square yard	0.0565

Oiling with 3-B Asphalt—Year 1924

Miles of streets oiled	10.95
Gallons of asphalt used—32,824 gals. @ 10 cts. per gallon	$ 3,282.40
232½ hours labor	143.19
433½ yards of pea gravel @ $2.00 per yard delivered	867.00
77½ yds. of No. 1 stone @ $1.00 per yard	77.50
72 hours labor spreading stone and dust and hauling same	144.00
63 yds. of sand @ $1.00 per yard	63.00
41 hours labor hauling and spreading sand	82.00
Total Cost	$ 4,659.09
Number of square yards oiled	185,870
Average cost per square yard	0.0250

Oiling with Tarvia B—Year 1924

Miles of streets oiled	49.91
Labor	$ 469.89
Tractor	260.25
1891½ yds. of pea gravel @ $2.00 per yard	3,783.00
130,545 gals. of Tarvia B @ 12 cts. per gal.	15,645.60
Total Cost	$20,158.74
Number of square yards	917,031
Average cost per square yard	0.0219

Total Oiling—Year 1924

Miles of streets oiled	61.647
Total Cost	$25,258.41
Number of square yards oiled	1,113,826
Average cost pet square yard	0.02267

observation the experiment has been successful and especially for a high-crowned street, as the gravel does not have a tendency to roll down toward the gutter.

Oiling with Tarvia B—Year 1925

Miles of streets oiled	22.908
Labor	$ 214.98
Tractor	116.00
700.1 yds. of pea gravel @ $2.00 per yard	1,400.20
73,933 gals. of Tarvia B @ 12 cts. per gallon	8,871.96
Total Cost	$10,603.14
Number of square yards oiled	335,399
Average cost per square yard	$ 0.031

During 1925 the gravel was spread on the road surface prior to oiling except at such times as we were unable to keep ahead of the oiler. It must be admitted, however, that this method consumes more bituminous material, but we are satisfied that it gives the roadway a better wearing surface.

Spreading ¾ in. Stone After Penetration of Bituminous Material

It will be noted that different grades of bituminous material have been used for this work, the purpose being to determine which will give the best results. The materials used have been Tarvia B, Texaco 110 penetration asphalt, road oil and Indian Refining Company 200 penetration asphalt.

If all surface treatment had been applied on an 18-ft. roadway, it would cover a distance of 556,913 lin. ft., or 105.47 miles.

During 1924, for experimental purposes, after some of the streets had been thoroughly cleaned, the pea gravel was spread first, after which the Tarvia B was applied. From our

Street Patrol Maintenance.—The two street maintenance patrols are made up as follows: Two 2-ton Republic trucks, on each of which is mounted a tar kettle having a capacity of 135 gal. The kettle is mounted at the rear of the truck. Two sheets of asbestos are placed on the truck body, over which is placed a sheet of 16-gauge iron. Removable side-boards are placed between the cab of the truck and the kettle. In this space is kept a steel barrel which contains bituminous material that is applied cold. The rest of the space is used for stone. The 2-wheel trailers are the type used by the aviation branch of the Army and were

made into substantial trailers for hauling different sizes of stone. The front end of the trailer box was made pointed to assist in making shorter turns, and in this portion are kept the tools, picks and shovels. A cover is placed over this end, and a slot is cut in the face part to allow the tools to be kept under lock and key. On either side of the truck cab Pyrene fire extinguishers are mounted. The cost of the street patrol outfit was as follows:

2 2-ton Republic trucks (second-hand) $1,000. each	$2,000.
2 135-gal. capacity kettles at $200. each	400.
2 trailers at $91. each	182.
Lumber and materials	80.
Labor	88.
Total cost of two street patrols	$2,750.

The organization for this work consists of two foremen, two kettle tenders, two truck drivers, and two skilled mechanics. Each street patrol has a certain portion of the city to look after and must confine itself to macadam streets, to patch any and all surface breaks, and to repair all utility service ditches caused by the installation of sewer, water, gas, electric, telephone or telegraph services. A flat rate of 20 ct. per square foot is charged against any and all utility firms, corporations, or individuals. The city sewer department and city water department must pay to the street department the cost of 20 ct. per square foot for all ditches patched.

Method of Making Patches.—Surface breaks in the pavement are thoroughly cleaned and the edges squared off, after which they are painted with bituminous material heated to the required temperature. Then, stone is placed and thoroughly tamped, the size depending upon the depth of the fracture. This is followed with heated bituminous material, the amount depending on the size of the stone. Stone ranging from ¼ in. to ½ in. is then spread over the surface and thoroughly tamped. The surface is finally painted with a thin coat of light tar or asphalt.

Utility service ditches are patched as follows: The edges of the ditch are squared off and cleaned out to a depth of 3 in. Stone ranging in size from 1¼ to 2½ in. is spread to a depth slightly below the surface of the pavement. The stone is thoroughly tamped, and heated bituminous material is applied at a rate of about 1.8 gal. per square yard. Then, stone ranging in size from ¾ in. to 1¼ in. is spread uniformly over the surface and this stone is thoroughly tamped after which bituminous material is applied at a rate of ¼ gal. per square yard. Stone ranging in size from ¼ in. to ½ in. is then spread uniformly over the surface. The surface is thoroughly tamped and generally is between ¼ and ½ in. above the surface of the old street. The edge, however, is even with the old surface. In order to keep the fresh stone from being swept away by vehicles, the surface is treated with bituminous material applied cold.

We have been very successful in having men stay with the department for some time, thus making experienced men available for our

Spreading Pea Gravel

work. The foreman works as much as the men, and at the same time sees that everything is placed properly. The kettle-men keep the material heated to the required temperature and apply all the material; thus they become efficient in estimating the amount of material to apply. The truck drivers are required to assist the laborers in filling the holes with stone and in tamping. We have found that by using 1 gal. of bituminous material per square yard for every inch in depth, we secure the best results.

Suggestions for Penetration Work.—To obtain excellent results in penetration work, use a very good durable crushed limestone, granite or gravel free from dust and organic matter. When using gravel be sure that at least 60 per cent of the gravel is crushed or broken to insure a mechanical bond. Do not roll the stone until it fractures and pulverizes before asphalt is applied, as this will not permit the penetration of the asphalt. The asphalt should fill the voids in the stone. Do not attempt to apply asphalt on a damp or wet surface. The asphalt should have the proper melting point and penetration which is governed by the climate and traffic. Asphalt should be heated to a temperature of not less than 300° F. nor more than 350° F. Use steam heat where possible. Make the surface as smooth as possible. Use a 10 ft. straight edge to insure a smooth and lasting surface and last of all do not make excessive crowns. Invite your traffic over the whole area of your street.

Road Design to Meet Existing Conditions

In a paper presented last fall before the Boston Society of Civil Engineers, G. H. Delano, Maintenance Engineer State Division of Highways, cited the following examples of how the department had worked out road width and design to meet existing conditions: One road is between Canton and Stoughton, Mass., on a route that is heavily traveled, and receives a large amount of heavy trucking. The surface is being constructed of two strips of concrete, each 10 ft. in width, separated by an 8-ft. strip of bituminous macadam. On such a road the benefit to be derived from this design is very apparent. The two lines of travel passing in the opposite direction will each have a distinct lane of concrete to travel on, and will, without question, adhere to it, so that when a vehicle wishes to pass in the same direction it will be possible to do so, both easily and safely. The second road leads to the South Shore, on a route that receives a large summer traffic. Many of the vehicles are motor busses, but few are heavy trucks. This type of traffic does not require so much turning out to pass vehicles going in the same direction, but its volume does require a rapid outlet. Here the surface, if built as contemplated, is to be 40 ft. in width, thus providing for two lines of traffic in each direction.

Street Patrol Maintenance Outfit

Snow Removal With Rotary Plow

How 7 Miles of Road in Mt. Rainier National Park Were Kept Open for Winter Traffic

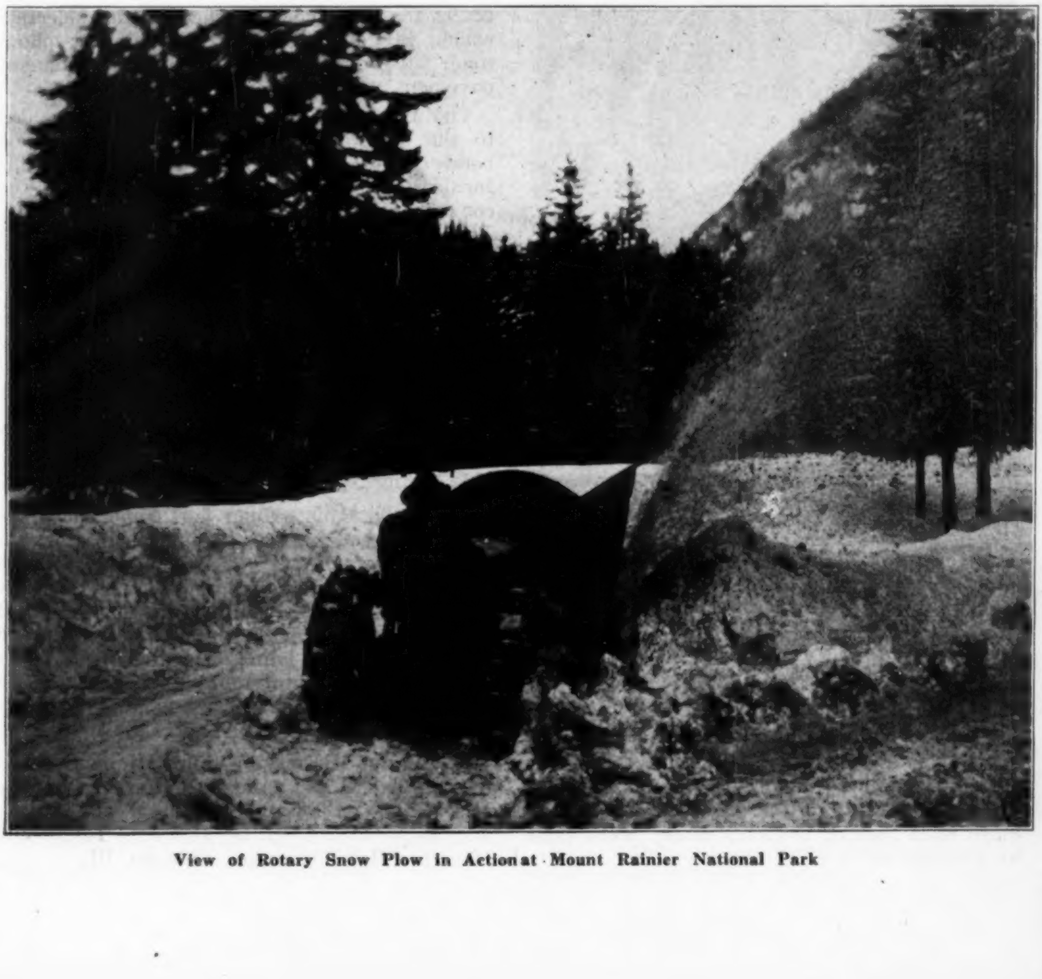
By O. A. TOMLINSON
Superintendent, Mount Rainier National Park

By means of a Fordson-propelled rotary snow plow, seven miles of road in Mount Rainier National Park were kept free of snow and open for automobile traffic during the winter of 1924-25. With the park road open for motorists over 10,000 people enjoyed winter vacations and wonderful snow sports.

The rotary snow plow was built by park mechanics in cooperation with the Seattle branch of the Ford Motor Co. The plow is attached to the front of and propelled by a Fordson tractor equipped with Trackson full crawler treads. The plow consists of a shell,

Side View of Rotary Snow Plow

or fan housing and the rotor, which is a steel disc 4 ft. in diameter to which are attached four blades. The plow is rigidly attached to the front of the Fordson. Power is transmitted to the rotor from the Ford pulley through a chain drive and a modified Ruckstell differential and axle. A ¼ in. steel apron, or



View of Rotary Snow Plow in Action at Mount Rainier National Park

scoop, set 2 in. above ground extends 12 in. in front of the rotor. As the machine moves forward this apron or scoop picks up the snow and feeds it into the rotor. The rotor turns at about one-third of the motor speed giving it about 250 to 300 r.p.m.

The curved blades of the rotor pick up the snow from the apron and discharge it at a point between "8 and 11 o'clock," throwing it from 10 to 30 ft. high and from 10 to 30 or

Front View of Fordson Driven Rotary Snow Plow Developed in Mount Rainier National Park

40 ft. from the machine. The blades of the rotor break up the snow into fine particles scattering it in a thin layer outside the right-of-way. The snow is so completely disposed of that the entire accumulation of removed snow for the season is hardly perceptible.

The Fordson rotary will clear new or loose snow up to a depth of 2½ ft., and 5 ft. wide at a rate of 2 miles per hour. One man operates the machine and the cost of operation is no more than that of ordinary heavy work done by Fordson's.

The efficiency of the Fordson snow plow is limited to new or loose snow under 2½ ft. in depth. For greater depths, or for heavy or packed snow a more powerful machine is required.

Difficult Highway Construction

The California Highway Commission opened bids Dec. 21 on one of its most difficult jobs it has ever undertaken. The contract calls for paving of six miles of highway in Imperial County across the famous Sand Hills, a barrier that has interfered with travel since the days when early explorers and missionaries plodded their weary way into California over the old Spanish Trail. Alternative bids were received for placing a cement concrete pavement 20 ft. wide, with thickened edges and center, and for an asphalt concrete pavement of the same width. Both will have a minimum thickness of 6 ins. with 9 in. edges.

The call for bids for the Sand Hills section came after many months of intensive study of the situation. The engineers of the commission have reached the conclusion that the project is feasible and that the location selected, which, in general, follows the present plank road, will permit the placing of a permanent pavement.

The El Centro-Yuma connection was added to the state highway system by the second bond act of 1915. Motor travel into California by this route was impossible until the construction of the present plank road in 1916. This movable road of timbers is now rapidly deteriorating and increasing traffic demands its replacement with a permanent surfacing.

The water hazard for contractors was removed recently when the commission drilled a well 153 ft. deep in Open Valley, on the route of the highway within the Sand Hill area, and secured a remarkable flow of water suitable for use in paving operations. Contractors will be permitted to use this water and a considerable saving to the state is expected as a result.

The Sand Hills extend north and south for 60 miles, reaching into Mexican territory at their southern limits. There is no alternative for an all-American road but to cross this barrier. The location will be one of the most spectacular on any federal aid highway in America. It will join California and Arizona on a transcontinental route that is not closed to traffic at any season of the year.

Meeting of Mississippi Valley Highway Engineers.—The 18th annual conference of the Mississippi Valley Association of state highway departments will be held Jan. 14, 15 and 16 at the Hotel Sherman, Chicago, Ill.

Resurfacing Old Roads with Concrete

Method of Laying New Top Course on Syracuse Test Road Described in Paper Presented October 27 Before American Society for Municipal Improvements

By H. ELTINGE BREED

Consulting Highway Engineer, 507 Fifth Ave., New York City

The Syracuse Road was built at Syracuse, N. Y., this summer, and finished in September under the auspices of the New York State Highway Department, under immediate supervision of Colonel William M. Acheson, Division Engineer. The information derived will benefit not only New York State but every engineer who is interested in giving his community good concrete pavements. The motive for the Syracuse Road was the realization that in many cities, streets would have to be widened and strengthened and that much resurfacing would soon have to be done. Pavements that have already been resurfaced with concrete, have been satisfactory in all cases I know of, but they have left many doubts in the minds of Engineers about what would prove most truly economical in design and procedure. Before we consider the test road, let me suggest two interesting jobs in resurfacing.

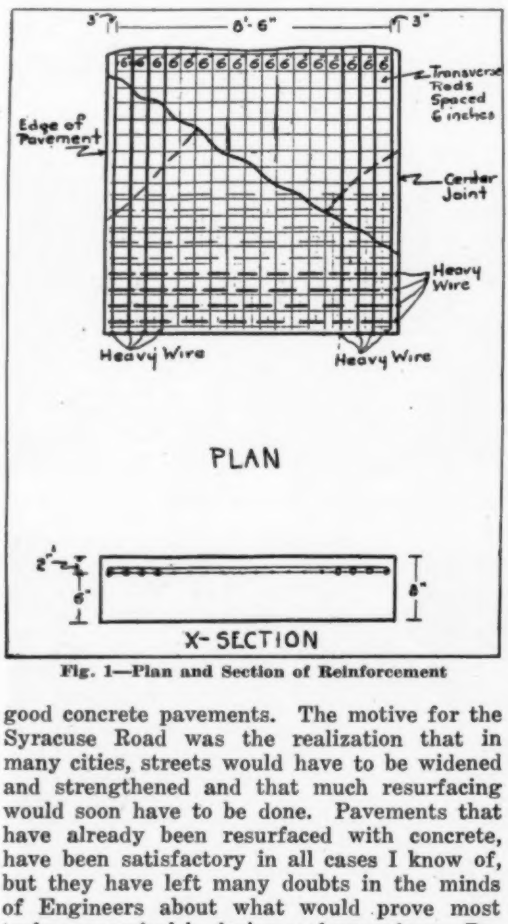


Fig. 1—Plan and Section of Reinforcement

Original Construction of Road.—The Syracuse Test Road, formally known as Syracuse Cicero State Highway , was built in 1914 of 1:1½:3 concrete, 16 ft. wide, 4¾ in. thick on the outside edges and 6¾ in. thick at the center. This pavement was still giving good service but some of the areas were badly cracked.

The idea in resurfacing at this time, was to utilize all of the pavement which still had a salvage value. The old pavement is an example of some that were built with an excessively fine sand of low strength. A traffic count shows 10,000 vehicles over it in 24 hours.

The Resurfacing and Widening.—The resurfacing has consisted of placing a top course with sections 450 ft. long of the following thicknesses: 2¾, 3½, 4, and 4½ in. Reinforcement of three different weights were used with each thickness. In addition to the resurfacing, a new strip, 8 ft. wide, was placed longitudinally to give a pavement 24 ft. in width. The whole job is over a mile in length. The 8 ft. slab was laid in thickness of 6 in., 7 in., and 8 in., and reinforced with various weights of reinforcing, some of it placed both top and bottom. There were also some unreinforced sections of the 7 and 8 in. thickness.

Reinforcement.—Steel fabric and bar mats were the type of reinforcing used, but there were no combinations of the two. Edge strength on the resurfacing and new slabs, was secured in the steel fabric mats by using heavier wire at the edge, and also with sheets of metal wider than the slab, turned down along the edge so that a heavy member is placed at the bottom. Additional end strength for the new slab as shown in Fig. 7, was secured by cutting a sheet of metal in two and using one half at each end of the slab with the heavy members running across the pavement. This method means using only one kind of steel on the job. It is an excellent method of reinforcing for loading at unsupported corners, for as the bending moment increases, the area of concrete and steel increase, thereby increasing the resisting moment.

Bar mats were also used, both single and double layer in part of this work. These were

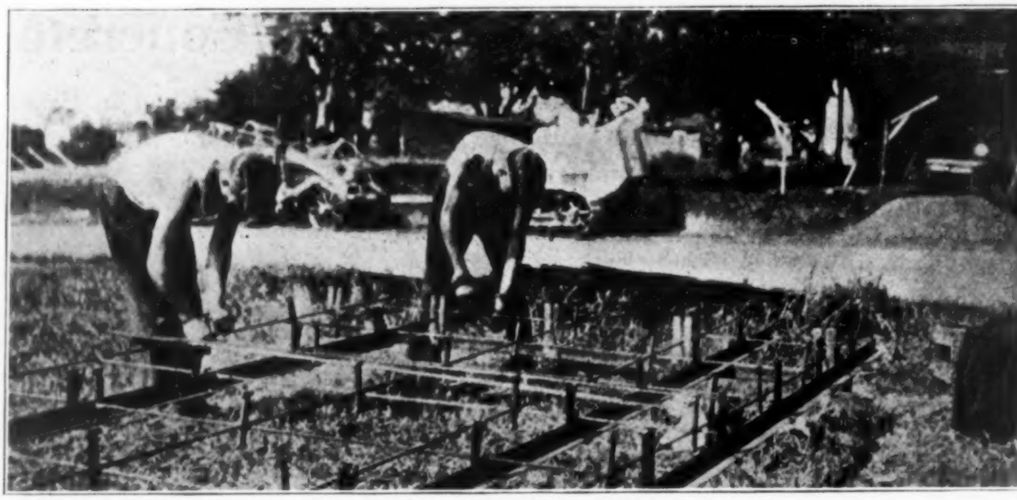


Fig. 2—Assembling Bar Mats

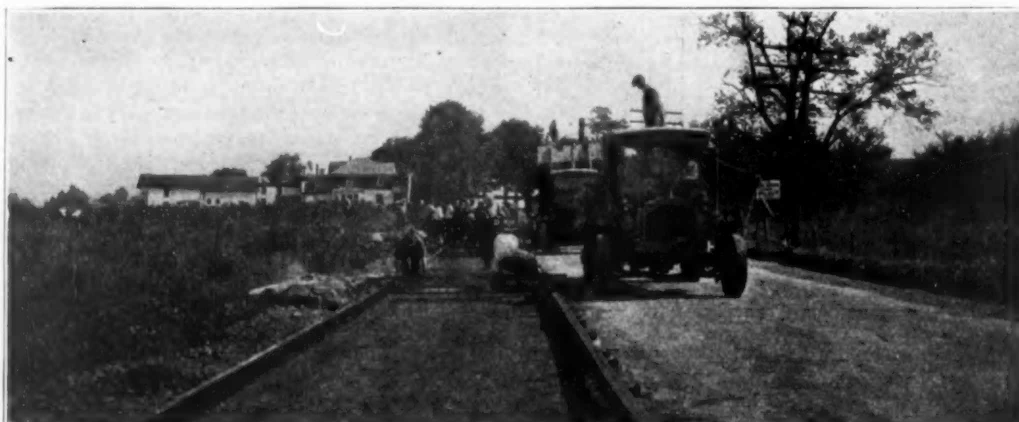


Fig. 3—Subgrade for New 8-ft. Strip, the Old Pavement and Subgrade Tester

Fig. 4—New Side Strip Beside Old Pavement and Condition of Latter in Cracks and Broken Areas

Fig. 5—Showing How Badly Broken Some Areas Were

assembled on the ground as shown in Fig. 2. Figure 3 shows the subgrade for the new strip and the old pavement, and the subgrade tester. Figure 4 shows the new side strip beside the old pavement, and condition of the latter in cracks and broken areas. Figure 5 shows how badly broken some areas were.

The Forms.—The forms were of two 2 in. strips of wood bolted together so as to break joints and of the height required for the section they were to be used for. Iron straps were fitted to the sides and they were placed and held by iron pins set in holes drilled in the concrete. The proper position was se-

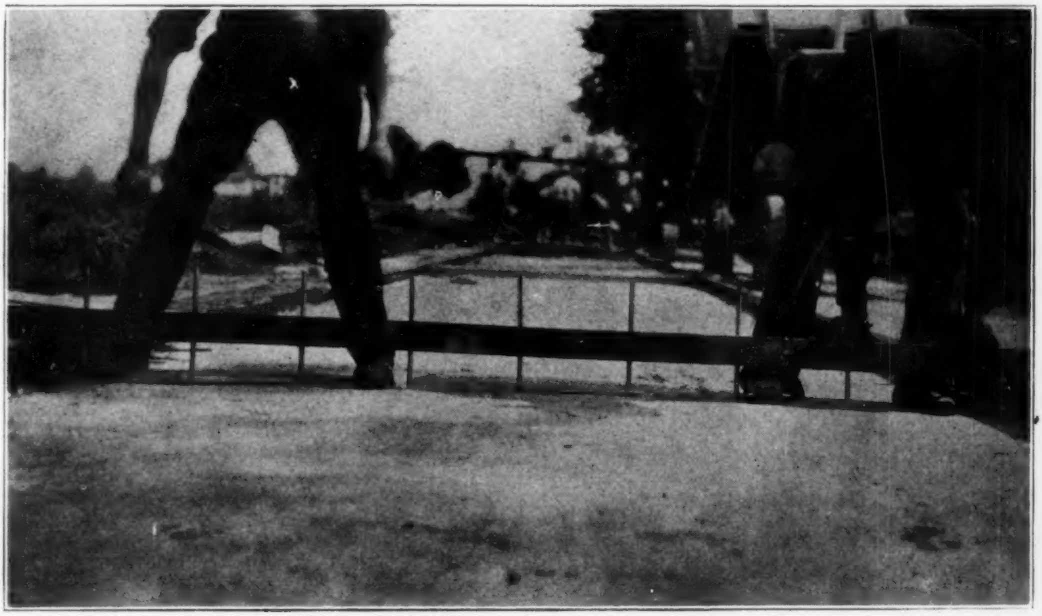


Fig. 6—Template Used So That Joint Material Could Be Made to Fit Surface

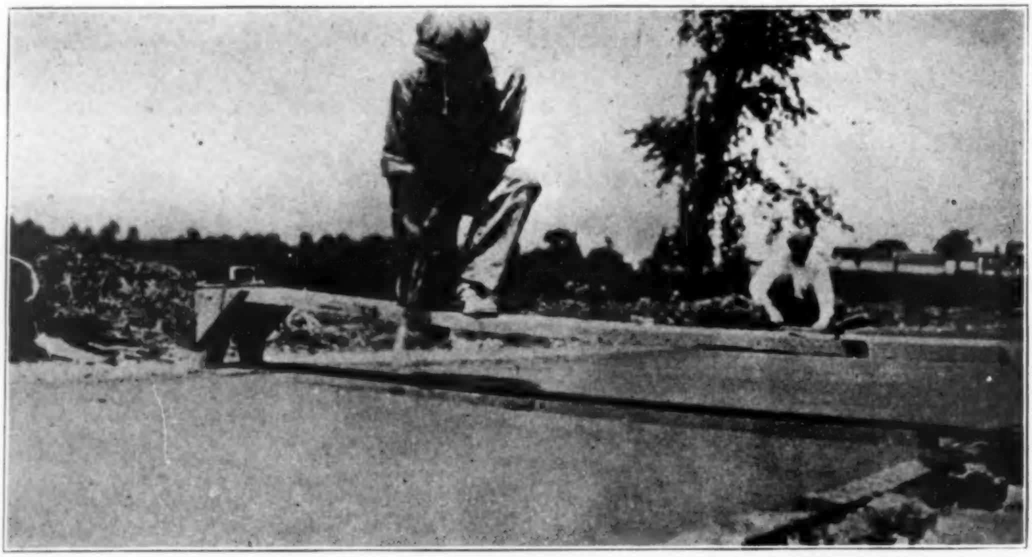


Fig. 7—Pulling Hard Paper Core After Concrete Had Been Edged, Metal Cap Raised and Binding Paper Slit

cured by the use of blocks around the pins, while top elevation was secured by shims.

The Joint.—Figure 6 shows the template used so that the joint material could be made to fit the surface. Corrugated paper joint material composed of two layers of corrugated paper with a hard paper core was used. Later the core is pulled when the two sides can easily be lifted. After the concrete has hardened, the joint is poured with a bituminous mastic. The paper joint has a metal cap on the upper side to strengthen it.

Figure 7 shows the pulling of the hard paper core after the concrete has been edged, the metal cap raised, and the binding paper slit. Figure 8 shows the placing of the steel

Fig. 8—Placing Steel Fabric on Roughly Leveled Concrete of 3-in. Slump Consistency

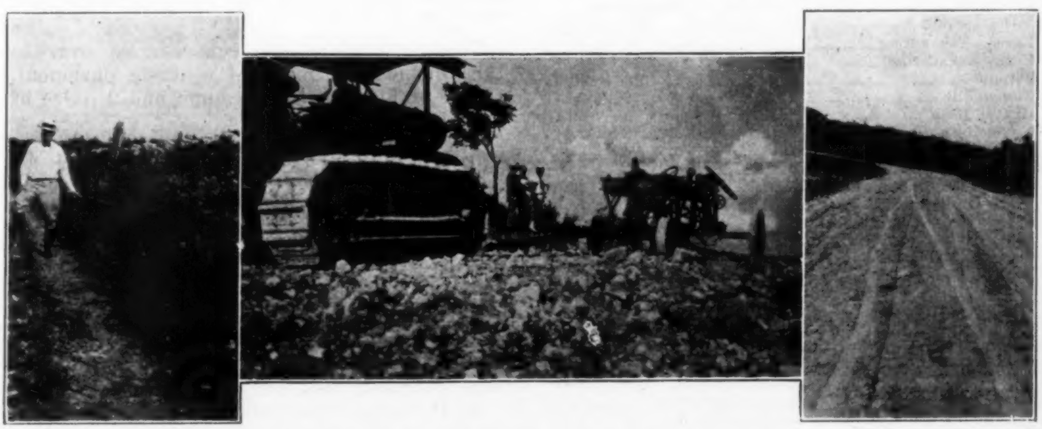
fabric on roughly leveled concrete of 3 in. slump consistency which once placed, held its position on the concrete as a snow shoe does on snow.

Problems It Is Hoped to Solve.—Some of the problems we hope to solve when the tests are made on this road after next Spring's thaws, are whether the cracks in the old pavement will come through and cause disintegration of the new surface. By how much greater depth of new surface will weaknesses in the old pavement be corrected? What is the minimum thickness on which the new surface can be designed? How much strength is gained through different quantities of reinforcement? How much steel is it economical to use?

Demonstration Road in Cuba

How a Gravel Road Was Made from an Ox-Cart Trail

Converting an ox-cart trail to a gravel road was the purpose of a road building demonstration carried out last fall near Nazareno in the Province of Havana.



Left—View of Portion of Road before Scarifying and Grading. Center—Scarifying Operations. Right—The Completed Road.

The road selected for the demonstration was about 25 miles from Havana. The original road was little more than a trail about 16 ft. wide between two stone fences on either side. It had been used by pack horse and two-wheeled ox-carts for so many generations that it was useless for any other vehicle purposes. The carts had cut through the top soil to the solid rock and had worn ruts in the rock 15 in. deep in spots. The center of the road averaged 2 to 4 ft. below the banks on each side.

The first step was the removal by hard manual labor of the stone fences to permit the trail to be scarified, graded, and widened to 22 ft., shoulder to shoulder. During the scarifying of the road with the scarifier, rocks were torn up which were so large that they could only be loaded in 2-wheel dump carts and hauled away by natives to low places in the road, to be used for fill and covered with dirt. After the scarifying the road was thoroughly bladed down and surfaced.

The demonstration was carried out by the Stockland Road Machinery Co., in co-operation with the Havana Fruit Co. A Stockland grader with a 12 ft. blade and a Stockland scarifier were shipped to Cuba for use in the demonstration which was under the direction of C. T. McGrew and H. J. Schreiner, of Stockland headquarters. They were assisted by V. B. Milian, president of the Havana Fruit Co.

Legal Service for Engineers

The American Association of Engineers is now planning to establish a legal service bureau to furnish legal advice to its members and to undertake research work in connection with problems of engineering law. Where simple questions only are involved, the services will be rendered gratuitously to members of A. A. E.; but where the submitted problem is complicated and extensive research is involved, a reasonable charge will be made to cover the cost of the service, in order that the bureau may ultimately become self-sustaining. A guiding purpose of this bureau will be to keep engineers out of law suits. The plans for the inauguration of this feature of A. A. E. service are now being developed by the committee on engineering law (Wm. Boone Douglass, chairman) with the advice and assistance of Morris Bien, Past-President of the Association.

State Highway Construction in 1925 and 1926

Reports from State Officials Showing Mileage and Expenditures Last Year, and Proposed Mileage and Funds Available for This Year

New England States

Maine

State highway completed in 1925 included 11½ miles of bituminous macadam of an average width of surface of 18.7 ft. and 18.7 miles of 18 ft. gravel road. The estimated average cost of the first mentioned was $34,038 per mile, and of the gravel road $21,403 per mile. The uncompleted work carried over to 1926 comprised 6.32 miles of 26 ft. wide concrete and bituminous macadam, 10.4 miles of 18 ft. bituminous macadam, and 40.9 miles of 18 ft. gravel road.

The average unit bidding prices on the 1925 work were as follows:

Unit Prices on Maine Contracts Awarded in 1925

Description	Unit	Number of Bids	Average
Earth Excavation	cu. yd.	16	$ 1.19
Rock Excavation	cu. yd.	14	4.11
Borrow	cu. yd.	16	1.23
Stone Fill	cu. yd.	8	2.34
Gravel Base	cu. yd.	9	2.31
Stone Base, Gravel Finish	cu. yd.	9	2.64
Stone Base, Cr. Stone Finish	cu. yd.	4	3.96
Gravel sub-base	cu. yd.	13	2.35
Stone V-Drain	cu. yd.	1	2.80
Side Underdrain	cu. yd.	2	2.65
Class "A" Concrete	cu. yd.	15	30.27
Class "B" Concrete	cu. yd.	16	27.69
Cement Rubble-Masonry	cu. yd.	1	.15
Rip-rap	lin. ft.	1	3.00
Laying 12 in. C.M.P.	lin. ft.	15	.83
Laying 14 in. C.M.P.	lin. ft.	11	.88
Laying 16 in. C.M.P.	lin. ft.	11	1.10
Laying 18 in. C.M.P.	lin. ft.	10	1.22
Laying 20 in. C.M.P.	lin. ft.	5	1.38
Laying 24 in. C.M.P.	lin. ft.	8	1.52
Laying 12 in. C.I.P.	lin. ft.	2	1.00
Laying 16 in. C.I.P.	lin. ft.	9	1.50
Laying 18 in. C.I.P.	lin. ft.	7	1.68
Laying 24 in. C.I.P.	lin. ft.	6	1.87
Laying 30 in. C.I.P.	lin. ft.	2	3.00
Drop Inlets	each	6	57.50
Cobble Gutters	sq. yd.	8	1.44
Gravel Road	cu. yd	11	2.61
Crushed Stone base course	cu. yd.	5	4.83
Bit. Macadam surface course	cu. yd.	8	5.64
Bit. Material app. (cars)	gal.	8	0.10
Bit. Material app. (bbls.)	gal.	8	0.075
Portland Cement Conc. pavement	cu. yd.	3	12.17
Pavement Reinforcing	lb.	3	0.0433
Wood Guard Rail	lin. ft.	14	0.59
Wire Fence Guard Rail	lin. ft.	2	0.75
Laying 12 in. Vitrified Pipe	lin. ft.	1	0.75
Laying 16 in. Vitrified Pipe	lin. ft.	1	1.00

The new highway work proposed for 1926 calls for a probable expenditure of $2,933,000 as follows:

New Highway Work Proposed For 1926

Type	Miles	Probable Expenditure
Concrete and Bituminous Macadam	12.66	$ 824,400
Reinf. Concrete	17.0	705,000
Bituminous Macadam	6.2	186,000
Gravel	81.1	1,218,000

Paul D. Sargent, Augusta, Me., is chief engineer State Highway Commission.

Vermont

The following table gives some details of the state highway work completed in 1925 on federal aid projects:

Vermont State Highway Completed in 1925 as Federal Aid Projects

	Miles	Av.width Sur. ft.	Thickness In.	Av.Cost Per Mile
Concrete Plain	3.3	18	9-6-9	$45,000
Concrete Reinforced	1.9	18	7	45,000
Bituminous Macadam	5.1	18	9x	31,000
Gravel	12.7	21-24	5-8-5	24,200

Graded and Drained—Covered in the above types of road.
x3 in. top, 6 in. base.

The uncompleted projects carried over to 1926 include 2½ miles of concrete pavement, 1 mile of bituminous macadam and 9 miles of gravel.

The new highway work proposed for 1926 is as follows:

New Highway Work Proposed for 1926

Type	Miles	Probable Expenditure
Concrete	3.0	$145,000
Bituminous Macadam	10.0	418,000
Gravel	4.0	120,000

The above estimates are approximate only, and are dependent upon the final road programme for the state for 1926 which has not been definitely laid out at this time.

S. B. Bates, Montpelier, Vt., is state commissioner of highways.

New Hampshire

The state highway completed during 1925 included 114½ miles of gravel road, 4½ miles of reinforced concrete, 3 miles of modified asphalt and 17.3 miles of bituminous macadam. Details of this work are given in the accompanying table.

New Hampshire State Highway Completed in 1925

	Miles	Av.width Surface ft.	Thickness In.	Av.Cost Per Miles
Concrete Reinforced	4.55	18	9-6-9	$41,770
Mod. Asphalt (Recon.)	3.00	18	2	18,210
Bituminous Macadam	17.34	18	3	31,592
Gravel	114.52	21	x4	19,987

x10 in. center, 4 in. edges.

Uncompleted Work Carried Over to 1925

Type	Miles
Bituminous macadam	3.00
Gravel	7.00

The average unit bidding prices in 1925 were as follows:

Average Unit Bidding Prices 1925

Items	Quantities	Average Bid
Earth excavation	cu. yd.	$ 1.36
Structure excavation	cu. yd.	3.33
Borrow	cu. yd.	1.39
Gravel borrow for shoulders	cu. yd.	2.07
Ledge	cu. yd.	4.19
Foundation course gravel	cu. yd.	2.22
Foundation course Field Stone	cu. yd.	3.28
Scarifying	cu. yd.	0.11
Bottom course gravel		2.16
Bottom course crushed gravel		2.92
Bottom course modified asphalt		----
Bottom course crushed stone		3.35
Surface course gravel		2.35
Surface course crushed gravel		3.05
Surface course modified asphalt		0.74
Surface course Bit. Macadam Broken stone		4.05
Surface course Reinf. concrete		2.78
Surface course trap rock		4.04
Applying bituminous material		0.07
Concrete class 1		27.54
Concrete class 2		21.88
Cement stone masonry		14.14
Rip-rap		3.20
Cobble gutter		1.68
Laying 8 in. C.M. Pipe	lin. ft.	1.08
Laying 12 in. C.M. Pipe	lin. ft.	1.03
Laying 14 in. C.M. Pipe	lin. ft.	1.02
Laying 16 in. C.M. Pipe	lin. ft.	1.14
Laying 18 in. C.M. Pipe	lin. ft.	1.25
Laying 20 in. C.M. Pipe	lin. ft.	1.26
Laying 24 in. C.M. Pipe	lin. ft.	1.63
Laying 30 in. C.M. Pipe	lin. ft.	2.11
Wood guard rail	lin. ft.	.69
Cable guard rail	lin. ft.	.80
Reinforcing steel	lbs.	.09

The probable expenditure for new highway work in 1926 cannot be determined until the town budgets are made up. However, it is proposed to construct the following:

Type	Miles
Gravel	100.00
Bituminous Macadam	20.00
Modified Asphalt	5.00
Reinf. concrete	5.00

Frederick E. Everett, Concord, N. H., is state highway commissioner.

Massachusetts

The state highway completed in 1925 included 3.8 miles of dual type road, consisting of two 10 ft. reinforced concrete slabs with an 8 ft. bituminous macadam strip between. In addition 38 miles of reinforced concrete pavement with 3 ft. bituminous macadam shoulders were completed. Details of the 1925 work follow:

Massachusetts State Highway Completed in 1925

	Miles	Av.W'th Sur.ft..	Thickness In.	Av.Cost Per Mile
Concrete Reinforced	38.0	20x	8	$66,000
Bituminous Macadam	35.6	24 to 27	4 to 6	45,000
Gravel	1.0	18	----	20,000
Sand-Asphalt	13.1	20	----	20,000
Graded and Drained	2.3	36	----	20,000
Dual Type	3.8	28	----	65,000

xWith 3 ft. bituminous macadam shoulders.

The uncompleted work carried over to 1926 included 2 miles of reinforced concrete pavement; 12.9 miles of bituminous macadam; 0.1 mile gravel.

The 1926 program has not been definitely decided. It probably will be the same as in 1925 with possibly a slight increase.

Arthur W. Dean, Boston, Mass., is state highway engineer.

Rhode Island

The state highway work completed in 1925 included 15 miles of reinforced concrete pavement, 2.6 miles of sheet asphalt, 14.7 miles of bituminous macadam and 2.9 miles of waterbound macadam. In addition the following uncompleted work was carried over to 1926: Reinforced concrete pavement, 12 miles; bituminous macadam, 12 miles; bituminous concrete, 2½ miles; gravel road, 3½ miles. Details of the work completed in 1925 follow:

Rhode Island State Highway Work Completed in 1925

Type	Miles	Average Width Surface feet	Thickness in.	Av. Cost per Mile Metalled Surface only
Reinf. Cement Con.	15.0	18	8	$30,000
Sheet Asphalt	2.6	18	9x	30,000
Bituminous Macadam	14.7	18	8	17,500
Waterbound Macadam	2.9	18	6	18,000

x3 in. on 6 in. concrete base.

In addition to the work carried over it is hoped to complete the following in 1926:

Type	Miles	Probable Total Expenditure Involved
Reinforced Cement Concrete	17.0	$850,000
Bituminous Macadam	8.5	340,000
Gravel	3.0	60,000
Waterbound Macadam	5.5	165,000
Sheet Asphalt	1.0	60,000

George H. Henderson, Providence, R. I., is chief engineer State Board of Public Roads.

Connecticut

The following table shows the total mileage of highway completed under all appropriations for the fiscal term ended June 30, 1925:

Mileage of Connecticut Highway Completed for Fiscal Term Ended June 30, 1925

	Trunk Line Construction Miles	Trunk Line Reconstruction Miles	State Aid Construction Miles	State Aid Reconstruction Miles
Graded	.00	.00	1.67	.43
Gravel	.19	.00	1.00	.00
Stone Surface	.00	.00	.00	.00
Macadam	18.99	.33	8.25	3.17
Bit. Macadam	3.93	10.70	2.07	.18
Bit. Concrete	.03	5.12	.00	.00
Concrete	11.13	35.62	4.84	5.92
Brick	.00	.00	.00	.00
Totals	34.27	51.77	17.83	9.70

The following table shows the details of work uncompleted at the close of the fiscal year June 30, 1925, giving mileage by types, estimated cost, amount paid and estimated

amount due of road contracts; also similar details of various bridge contracts uncompleted at this date:

Uncompleted Connecticut State Highway Work on June 30, 1925

	Miles	Total Cost	Paid
Macadam	68.31	$2,367,626	$1,104,361
Bituminous Macadam	22.00	828,886	362,417
Bituminous Con.	8.17	125,700	40,943
Concrete	34.81	1,972,199	905,752
Miscellaneous	....	315,585	186,308
Totals	133.29	$5,609,997	$2,599,783
Bridges	....	193,420	162,617
Gross amounts	....	$5,803,417	$2,762,401

John A. MacDonald, Hartford, Conn., is state highway commissioner.

Middle Atlantic States

New York

Contracts for state highway work awarded in 1925 covered 720 miles of roads. The appropriation was $38,000,000. It is expected that about the same amount of work will be undertaken in 1926.

Paul Schultze, Albany, N. Y., is deputy commissioner of highways.

Pennsylvania

During 1925 seven hundred and sixty miles of reinforced concrete pavement was completed under the direction of the state highway department. In addition 275 miles of uncompleted reinforced concrete pavement was carried over to 1926. Details of the state highway completed in 1925 follow:

Pennsylvania State Highways Completed in 1925

	Miles	Av. Width Surface ft.	Thickness In.	Av. Cost Per Mile
Concrete Reinforced	7.60	16-18	8-6-8	$50,000
Brick	0.07	18	4	....
Sheet Asphalt (Resurfacing)	9.11	20	Var.	....
Bituminous Concrete	*17.31	16	2½	....
Bituminous Penetration macadam	**29.95	16-18	4	....
Macadam, Bit. Surf. Treated	***115.73	16	4	....
Macadam oil bound	98.06	16	3	....
Graded and Drained	81.97	16-18	..	20,000

*12.20 miles resurfacing included.
**28.37 miles resurfacing included.
***74.20 miles resurfacing included.

The new highway work proposed for 1926 includes the construction of 590 miles of reinforced concrete pavement at a probable expenditure of $30,000,000.

W. H. Connell, Harrisburg, Pa., is engineering executive and deputy secretary of highways.

New Jersey

The 1925 road program called for the construction of 113 miles of roads costing $11,815,000. Of this, 92 miles, averaging $63,000 per mile were completed. The bridge program called for an expenditure of $2,222,000 for 54 bridges. The total state, county and township and expenditures of the state was $21,500,000. The 1926 program will require about a same expenditure as last year, and the construction of practically the same mileage.

W. G. Sloan, Trenton, N. J., is state highway engineer.

South Atlantic States

Delaware

During 1925 a total of 71 miles of state highway was completed. This was plain concrete, 16 ft. wide, 8 in. thick at the sides and 6 in. thick at the center. The average cost per mile was $30,000. In addition 9 miles of plain concrete pavement was carried over to 1926.

The program for 1926 includes the construction of 70 miles of plain concrete, involving a probable expenditure of $2,500,000.

W. W. Mack, Dover, Del., is acting chief engineer of the state highway department.

Maryland

During 1925 the state roads commission completed 120 miles of concrete pavement, 17½ miles of water bound macadam and 40 miles of gravel road. The addition 4.77 miles of sheet asphalt were completed in city streets. A summary of the 1925 work is given in the following tables:

Maryland State Highway Completed in 1925

	Miles	Av. Width Surface ft.	Thickness In.	Av. Cost per Mile
Concrete, plain	120	15	6-8	$30,500
Street asphalt (city streets)	4.77	49	1½-1½	108,000
Macadam waterbound	17.5	15	8	14,100
Gravel	40	15	8	9,700

Uncompleted Work Carried Over to 1926

Type	Miles
Macadam (Waterbound)	8.5
Concrete (Plain)	25
Gravel	18
Asphalt	2

The probable expenditures for new highway work in 1926 total over $3,000,000 as follows:

New Highway Work Proposed for 1926

Type	Miles	Probable Expenditure
Gravel	35	$ 339,000
Macadam (Waterbound)	20	280,000
Concrete (Plain)	70	2,100,000
Asphalt	3.5	350,000

John N. Mackall, Baltimore, Md., is chairman and chief engineer of the State Roads Commission.

Virginia

The following table shows the state roads completed during the period July 1, 1924, to June 30, 1925:

Type	Miles	Cost
Concrete	125.52	$4,262,810
Bituminous macadam	85.29	2,347,594
Surface treated macadam	12.65	151,895
Gravel	37.44	560,490
Top soil	57.10	405,456
Graded	29.92	696,566
Miscellaneous	......	23,356
Total	347.92	$8,448,171

State aid construction completed from July 1, 1924 to June 30, 1925, was as follows:

Type	Miles	Cost
Concrete	20.84	$ 551,046
Bituminous macadam	32.80	568,755
Surface treated macadam	5.43	67,589
Water-bound macadam	22.10	207,186
Crushed stone	4.75	33,049
Gravel	69.31	413,839
Shell and shale	1.23	11,200
Sand-clay	24.16	27,744
Soil	22.54	45,485
Graded	70.15	360,121
Total	273.31	$2,286,018

It is not possible at this time to give definite figures on the 1926 construction program. The state highway department has allocated $7,060,000 for 1926 construction but it is expected this will be changed somewhat when the general assembly convenes in January.

C. S. Mullen, Richmond, Va., is chief engineer, state highway commission.

West Virginia

The total cost of the state highway work completed in 1925 was $17,681,685. Details of the work follow:

West Virginia State Highway Completed in 1925

	Miles	Av. Width Surface ft.	Thickness In.	Av. Cost Per Mile
Concrete Plain	60.88	16	7	$42,000
Brick	4.64	16	10	48,000
Bituminous Concrete	9.70	16	10	39,000
Bituminous macadam	180.59	16	11	36,000
Macadam, water bound	25.34	16	10	26,000
Gravel	60.78	16	8	17,000
Earth Road	384.41	26	....	12,500
Rock Asphalt	16.95	16	10	41,500
Shale-asphaltic oil surface coat	8.24	....	8	18,000

The uncompleted work carried over to 1926 was as follows:

Uncompleted Work Carried Over to 1926

Type	Miles
Graded and drained	152.38
Bituminous macadam	125.41
Concrete	95.06
Gravel	21.56
Waterbound macadam	12.00
Bituminous concrete	2.97
Brick	0.75

It is anticipated that $9,000,000 will be placed under contract in 1926, as this amount of bonds authorized by the legislature has not yet been offered for sale. Pending such sale, no plans by types and mileages have been made. However, the proportions will run somewhat as above.

C. P. Fortney, Charleston, W. Va., is chairman state highway commission.

North Carolina

The following table gives information on highway completed in 1925 or carried over to 1926:

North Carolina State Highway Work

	Miles Completed in 1925	Miles Uncompleted work carried over to 1926	Miles New work let late in 1925	Thickness In.	Average Unit Bids Per Sq. Yd.
Plain Concrete	252.67	54.56	186.95	6, 6⅔-7⅛	$2.30 to $3.00
Reinforced Concrete	17.01	0.0	0.0	6⅛	$3.00
Concrete Base	125.11	25.49	0.0	5	1.75
Asphalt Top	116.73	44.29	0.0	2	1.10
Sand Asphalt	73.59	2.99	15.33	5	1.75
Bituminous Asphalt	4.93	0.0	0.0	2	2.65
Waterbound Macadam	53.92	21.17	0.0	8	1.75
Sheet Asphalt	0.91	2.26	0.0	2	1.45
Top Soil, Sand Clay, and Gravel	219.26	65.63	5.54	....	0.45*
Graded	233.67	207.53	96.06	....	$0.35 to $0.50*
Total	1097.80	423.92	303.88		

Width of Hard Surface: 16 and 18 ft.
*Per cu. yd.

The program for 1926 calls for expenditure of from $20,000,000 to $25,000,000.

Charles W. Upham, Raleigh, N. C., is state highway engineer.

South Carolina

Construction of roads and bridges on the state highway system of South Carolina has been during 1925 under the program for the two years 1925 and 1926, according to the provisions of the act of 1924, which placed the construction, maintenance and financing upon the state highway department. Funds are supplied from motor vehicle licenses and gasoline taxes, supplemented by federal aid.

The program was to construct 925 miles of unpaved road at an estimated cost of $5,300,000, 75 miles paved to cost $2,400,000 and bridge work to cost about $2,500,000, making a total of $10,200,000 for the two years.

The income from the three sources mentioned was estimated to be $11,240,000, and

the total income was to include $3,500,000 to be advanced by counties which are to be reimbursed. This program was modified to some extent owing to amendments made in 1925 to the act of 1924, lengthening the period of construction.

The most important bridge completed during the year is that over the Savannah River about 8½ miles above the city of Savannah, being an essential link in the Atlantic Coastal highway. This was a joint state project and the bridge was opened to traffic in July.

The fine concrete bridge with bascule span over the Ashley River at Charleston is another essential link in the Coastal Highway. Traffic is now passing over this bridge although it is not quite completed. The length of the bridge with its approaches across the marsh is about ⅞ of a mile. It will have a single track for street cars, a roadway 34 ft. wide and two 4½ ft. sidewalks. The total cost will be about $1,250,000.

During the year 11 major bridges have been under construction. The bridge across the Savannah River near Augusta was finally completed, and the bridges across Black River in Georgetown County and two bridges across the Saluda River have been completed. Construction is progressing on the bridges over the Combahee, Peedee, Upper Santee, Sampit, Beaufort and Catawba rivers. Contract has been awarded for bridge over Congaree River at Columbia, to cost $550,000.

At the end of November there were 4,341 miles of road under state maintenance, of which 310 miles are paved.

Charles H. Moorefield, Columbia, S. C., is state highway engineer.

Georgia

The following table gives some detail of the State highway work completed in 1925:

Georgia State Highway Completed in 1925

	Miles	Av. Width Surface ft.	Thickness In.	Av. Cost Per Mile
Concrete Plain	56.	18	9-6-9	$26,194
Sheet Asphalt	7.6	18	1½ on 9x	24,662
Bituminous Macadam	16.5	18	9x	22,000
Macadam water bound	4.8	12	6	12,000
Gravel	112.6	18	6	14,695
Top Soil	133.9	26	10	6,671
Graded and Drained	25.7	26	—	4,516
Surface treated	12.9	18	—	18,000

x1½ in. on 7 in. base and ½ in. binder. x3 in. on 6 in. base.

The uncompleted work carried over to 1926 was as follows:

Uncompleted Georgia Work Carried Over to 1926

Type	Miles
Graded	126.5
Top-soil	276.5
Waterbound Macadam	8.8
Gravel and chert	103.7
Bituminous macadam	19.7
Surface Treated	84.0
Concrete	30.1

The proposed new highway work for 1926 is shown in the following table:

New Georgia Highway Work Proposed for 1926

Type	Miles	Probable Expenditure
Graded	60.0	$ 240,000
Top Soil	100.0	650,000
Waterbound Macadam	22.0	225,000
Gravel and Chert	45.0	616,000
Asphalt	33.0	660,090
Surface Treated	83.5	376,250
Concrete	90.0	1,980,000

W. R. Neel, East Point, Ga., is state highway engineer.

East North Central States

Michigan

Up to Nov. 1, 1925, there was a total of 448 miles of surfacing laid in the state since Jan. 1, 1925. Of this total 246.5 miles were concrete, 190.5 miles gravel and approximately 11 miles of hard surfacing other than concrete.

There is a total of approximately 6,500 miles of road in the determined trunk line and non-trunk line federal aid system in the state of Michigan. This does not include a considerable mileage of roads which are marked and maintained by the state as trunk line, but which have not been legally determined. Of this total approximately 1,300 miles are concrete, 3,500 miles are gravel, 890 miles are hard surfaces other than concrete, and the remainder earth, sand-clay, etc.

In the 9 years since the Michigan State Highway Department assumed responsible charge of the construction of Michigan roads over eight times as many miles of road has been built as was completed in the nine years previous to 1917. The percentage of concrete surfacing has increased from 1 to 50 per cent in that length of time.

Figures covering work carried over to 1926 and the proposed 1926 program are not available at this time. Very little work, however, which has been started this year is being carried over into the 1926 construction program.

This is the first year of operations under the new gasoline and weight tax, and the construction for next year will depend to a large extent upon the amount of money received from this source.

Frank F. Rogers, Lansing, Mich., is State Highway Commissioner.

Indiana

State highway completed in 1925 included 203 miles of reinforced concrete pavement, 25.9 miles of highway graded and drained, and 22.9 miles of pavement consisting of telford base and traffic bound surface. Details of the 1925 work are given in the following tables:

State Highway Completed in 1925

	Miles	Av. Width Surface ft.	Thickness In.	Av. Cost Per Mile
Concrete, reinforced	203.3	18	7	$27,669
Graded and drained	25.9	30	....	10,520
Telford base and traffic bound stone surface	22.9	16	....	13,571

Uncompleted Work Carried Over to 1926

Type	Miles
Concrete Pavement	71.170
Telford Base Stone Surface	37.043
Grading and small structures	0.192

The accompanying table gives data on 20 projects. Characteristics of the 1925 program.

Unit Prices on 1925 Indiana State Highway Work

Project	Miles	Contract Price without Cement	Price Bid on Pavement sq. yd. (State furn. Cement)	Price Bid on Excavation sq. yd.
21 A-E	9.467	$ 182,323	$1.39	$0.60
46 A-B	11.976	234,708	1.36	.45
46 C	8.312	171,829	1.43	.45
72 A	5.704	108,613	1.33	.60
72 B	6.425	122,240	1.25	.60
73 A	4.303	87,101	1.47	.50
80 A	10.477	169,169	1.00	.50
83 A & B	12.002	216,482	1.35	.35
89 A	9.811	204,704	1.31	.50
78 D	8.862	162,853	1.26	.45
78 C	4.779	109,941	1.01	.37
78 E	9.560	210,747	1.25	.43
68 D	6.215	113,588	1.35	.35
82 A	4.688	101,416	1.30	.44
82 B	9.541	159,808	1.18	.46
69 D-75 B	12.664	225,462	1.22	.38
93 A & B	5.775	129,446	1.48	.60
84 A	8.430	172,790	1.33	.50
84 B-C	11.276	199,628	1.19	.44
94 A	5.852	98,783	1.15	.45
	166.119	$3,181,639		

Average cost per mile (cement furnished by state)	$19,152.77
Average cost of cement per mile	7,180.80
Total average cost	$26,333.57
Average bid per sq. yd. on Pavement (cement furnished by state)	$ 1.28
Average cost of cement per sq. yd.	.68
Total cost per sq. yd.	$ 1.96
Average bid on excavation unclassified sq. yd.	$ .47
Average bid on reinforcing steel per pound (approx.)	.0475
3.15 lbs. steel required per sq. yd. of pavement.	

Definite information concerning the 1926 program is not available at this time but it probably will consist of about 200 miles of hard surface pavement.

J. T. Hallett, Indianapolis, Ind., is assistant chief engineer of the state highway commission, in charge of roads.

Illinois

State highway completed in 1925 includes 878 miles of concrete pavement, 18 ft. wide, 6 in. center and 9 in. edges; 9 miles of 18 ft. brick pavement; 5 miles of 20 ft. water bound macadam; 7 miles of 12, 14 and 16 ft. wide gravel road and 169 miles of graded and drained 21 to 30 ft. wide road. The following table shows the average awarded cost of work let in 1925:

Average Awarded Cost Per Mile for 1925

	Width	Type	Average Awarded Cost
State Bond Issue	18	Concrete	$26,520.51
County 15-d	9	Concrete	16,610.91
County 15-d	18	Concrete	26,471.76
County 15-d	20	Concrete	34,460.48
County 15-d	Var.	Gravel	9,801.09
Total Awarded Cost for 193.86 Miles of Grading Was			$1,829,229.56

The uncompleted work carried over to 1926 was as follows:

Uncompleted Work Carried Over to 1926

Type	Miles
Concrete	148
Brick	2
Asphalt (Kentucky Rock)	2
Macadam, W. B.	2
Gravel	3

The 1926 program calls for a probable expenditure of $30,000,000 for the construction of 1,000 miles of concrete pavement.

Frank T. Sheets, Springfield, Ill., is chief highway engineer.

Wisconsin

The accompanying table gives a preliminary estimate of the state highway work accomplished in 1925:

Preliminary Report of 1925 Wisconsin Highway Work

	Federal Aid		State Aid		Gang Maint.		Totals		Cost
Grad. & Surf.	Miles	Cost	Miles	Cost	Miles	Cost	Miles	Cost	Per Mile
Concrete	53.6	$1,520,475	68.8	$2,030,529	....	$	122.4	$ 3,551,004	$29,050
Crushed stone	16.1	182,896	46.2	161,833	3.0	8,180	65.3	352,909	5,410
Gravel	77.6	888,089	759.0	2,216,977	307.7	500,242	1,144.3	3,605,308	3,142
Shale	.....	....	47.0	116,143	....	....	47.0	116,143	2,470
Others	0.6	17,309	24.7	72,101	2.2	3,569	27.5	92,979	3,379
Total	147.9	$2,608,769	945.7	$4,597,583	312.9	$ 511,991	1,406.5	$ 7,718,348	....
Graded only	54.9	481,657	720.4	871,405	245.7	138,011	1,021.0	1,491,073	1,461
Tot. new grad.	202.8	$3,090,426	1,666.1	$5,468,988	558.6	$ 650,002	2,427.5	$ 9,209,416	....
Surf'g only—									
Concrete	12.7	310,532	2.5	64,975	....	....	15.2	375,507	24,700
Macadam	.....	....	7.5	87,668	....		7.5	87,668	11,680
Crushed stone	8.3	23,585	45.0	74,305	27.3	30,280	75.6	128,170	1,680
Gravel	13.7	38,319	365.9	518,064	390.9	370,442	770.5	926,825	1,204
Others	.....	....	64.2	70,294	40.6	68,320	104.8	138,614	1,324
Total	29.7	$ 372,436	485.1	$ 815,306	458.8	$ 469,042	973.5	$ 1,594,284	....
Grand total	232.5	$3,462,862	2,151.2	$6,284,294	1,017.4	$1,119,044	3,401.1	$10,803,700	....

Definite figures for the 1926 construction are not yet available. It is estimated, however, that about 225 miles of concrete pavement will be constructed in 1926.

J. T. Donaghey, Madison, Wis., is state highway engineer.

East South Central States

Kentucky

The state highway department of Kentucky has built during the year 1925, 47 miles of cement concrete paving at a cost of approximately $34,000 per mile; 5 miles of native rock asphalt at $41,000 per mile; 78 miles of waterbound macadam at $26,000 per mile; 75 miles of gravel at $17,800 per mile; 175 miles of grade and drain at $14,700 per mile—a total of 380 miles at approximately $7,800,000.

The construction program for the calendar year 1926 will include possibly a like expenditure of money, but a less amount will be expended for high type paving in 1926 than has been expended in 1925; however, the large mileage of grade and drain projects will ultimately be surfaced with medium or high type paving.

In the state road system of the state there are approximately 8,000 miles, but only that portion of the state system is being maintained by state funds that has been brought up to a required standard. The state department is now maintaining 113 miles of cement concrete; 14 miles of bituminous concrete; 4 miles of brick; 147 miles of rock asphalt; 75 miles of bituminous macadam; 887 miles of bituminous surface treated macadam; 81 miles of waterbound macadam and 487 miles of gravel. Besides these surfaced roads being maintained, 369 miles of earth road, constructed to modern standards, is being maintained in good condition for nine months of the year. Approximately $1,500,000 per year is being used by the maintenance division. This state has a big mileage of surface treated macadam that is being maintained in excellent condition, serving practically the purpose of high type paving, though the expenditure for maintenance in some cases is not economical.

The department has just in recent years had its revenue for road constrution very greatly increased by the 3 ct. gas tax, and now has revenue sufficient to make great progress; though the demands for the expenditures of funds are very great. This state is unfortunate in comparison with most of its neighbors in that the same amount of funds will not accomplish the same amount of construction as in the states where the topography is more favorable. A comparatively small number of miles have been surfaced in the eastern portion of Kentucky, and where grade and drain projects have been constructed, the cost has been greater than most states are required to pay for surfaced roads. There are not only the rugged mountains to contend with but most of the heavy cuts are made through solid rock.

During the year 1925, in addition to the construction of short sections of roads in cooperation with funds furnished by counties, the department has been able to close a number of gaps in the important roads crossing the state. Kentucky's roads are being widely advertised just now as the shorter routes for the southern travel. Three hard surfaced roads are open crossing the state: One from Covington, opposite Cincinnati, through Lexington, and Middlesboro to Cumberland Gap; another from Louisville through Bowling Green to the Tennessee line; and a third from Henderson, opposite Evansville, Indiana, through Hopkinsville to the Tennessse line. These three routes are carrying an enormous out-of-state traffic this season.

In addition to these north and south routes, beginning at Ashland and extending through the northeastern mountain section, through Lexington and the Bluegrass to Louisville and down the Ohio River through Owensboro and Paducah to the Mississippi River, a distance of 590 miles, splendid progress has been made. More than 100 miles of high type paving has been completed between Ashland and Louisville and only a short gap in this section is left to be surfaced.

E. N. Todd, Frankfort, Ky., is state highway Engineer.

Mississippi

The state highway work completed in 1925 included 1.65 miles of plain concrete pavement, 160 miles of gravel road and 31 miles of earth road. In addition the uncompleted work carried over to 1926 includes 75 miles of graded and drained road, 250 miles of gravel, and 60 miles of concrete.

The 1926 program includes the following:

New Highway Work Proposed for 1926

Type	Miles	Proposed Expenditure
Graded and Drained	60	$ 800.000
Gravel	80	1,300,000
Paving (Concrete)	27	700,000

H. C. Dietzer, Jackson, Miss., is state highway engineer.

West North Central States

Minnesota

State highway completed in 1925 included 85 miles of plain concrete, 440 miles of gravel and 328 miles of graded and drained road. In addition 101 miles of uncompleted graded and

drained road were carried over to 1926. Details of the completed work follow:

Minnesota State Highway Completed in 1925

	Miles	Av. Width Surface Ft.	Thickness In.	Av. Cost Per Mile
Concrete (Plain)	85	18	8-7-8	$25,000
Gravel	440	24	3-5	2,500
Graded and drained	328	32		6,000

The following table shows the new highway work proposed for 1926:

New Highway Work Proposed for 1926

Type	Miles	Proposed Expenditure
Reinforced Concrete	170	$4,500,000
Gravel Surfacing	200	500,000
Graded and Drained	115	1,000,000
Special Bridges		500,000

Charles M. Babcock, St. Paul, Minn., is state highway commissioner.

Iowa

State highway work completed in 1925 included 61.97 miles of reinforced concrete pavement, 18 and 20 ft. wide and 8 in. thick; 285.87 miles of 26 ft. wide 3½ in. deep gravel road; 330.29 miles of 28 ft. wide graded road.

Uncompleted work carried over to 1926 was: reinforced concrete, 21.65 miles; gravel, 61.72 miles; grading, 109.92 miles.

The new highway work proposed for 1926 is as follows:

New Highway Work Proposed for 1926

Type	Miles	Proposed Expenditures
Concrete	22.80	$ 673,000
Gravel	704.89	2,329,800
Grading	521.39	6,991,308

Fred R. White, Ames, Ia., is chief engineer, state highway commission.

North Dakota

State highway completed in 1926 includes 3 miles of reinforced concrete pavement, 271 miles of federal aid gravel road, and 415 miles of federal aid earth road.

The uncompleted work carried over to 1926 includes ½ mile concrete paving, 250 miles of federal aid earth road, and 150 miles of federal aid gravel road.

The new highway work proposed for 1926 is as follows:

New Highway Work Proposed for 1926

Type	Miles	Proposed Expenditure
Earth Road—Fed. Aid	600	$2,400,000
Gravel—Fed. Aid	500	1,000,000
Paving—Fed. Aid	20	100,000

H. C. Frahm, Bismarck, N. Dak., is chief engineer of the State Highway Commission.

Missouri

Over 1,233 miles of state highway were completed in 1925, and in addition 719 miles of uncompleted work were carried over in 1926. The following tables give details:

Missouri State Highway Completed in 1925

	Miles	Av. Width Surfaced ft.	Av. Cost Per Mile
Concrete, plain	465	18	$28,800
Concrete, plain	16	9	16,370
Bituminous Macadam	12	....	22,400
Gravel	350	16	3,940
Earth road	390	....	9,180

Uncompleted Work Carried Over to 1926

Type	Miles
Concrete	269
Gravel	240
Bit. Macadam	10
Graded Earth	200

The program for 1926 calls for a probable expenditure of $20,400,000 as follows:

New Highway Work Proposed for 1926

Type	Miles	Probable Expenditure
Concrete	400	$12,400,000
Gravel	600	6,600,000
Grading	200	1,400,000

B. H. Piepmeier, Jefferson City, Mo., is chief engineer State Highway Department.

South Dakota

The state highway completed in 1925 included 526 miles of gravel road, 110 miles of graded and drained road and 3 miles of sand-clay road. The gravel road had an average width of surface of 24 ft., and a thickness of 6 in. The average cost per mile was $5,422. The sand-clay construction had a surfaced width of 24 ft. and a thickness of 6 in.; the average cost per mile was $3,600. The average cost per mile of the graded and drained highway was $3,439.

The uncompleted work carried over to 1926 included 76 miles of gravel road, and 80 miles of graded and drained road.

The 1926 program calls for a probable expenditure of $2,862,000 and involves the construction of 425 miles of gravel road and 150 miles of graded and drained highway.

O. N. Heth, Pierre, S. Dak., is state highway engineer.

Nebraska

The total amount of state highway contracts placed in 1925 was $4,500,000. The following table gives some details of the work completed last year:

Nebraska State Highway Completed in 1925

	Miles	Av. Width Surfaced Ft.	Thickness	Av. Cost Per Mile
Concrete Plain	18.60	18	6 in. center, 9 in. edge	$22,600
Brick	0.579	18	5 in. base, 1 in. sand, 3 in. brick	38,348
Bituminous Concrete	.662	18	5 in. base	36,369
Gravel	906	21	3 in. base	2,500
Earth Road	450	24		2,000
Top Soil	90.71	24	8 in. base	2,675
Bridges	0.7	18		$100 per Lin. Ft.

The uncompleted work carried over to 1926 includes 400 miles gravel road, 100 miles earth road and 0.1 mile bridges.

It is expected that the season of 1925 will be duplicated in 1926 and about $4,500,000 of work placed under contract.

R. L. Cochran, Lincoln, Neb., is state highway engineer.

Kansas

Approximately $4,000,000 worth of state highway construction was contracted during the year and approximately the same amount completed during the year. The largest portion of this amount was expended for grading and culverts; however there was considerable bridge construction and some hard surface road construction.

For 1926 it is expected to spend between 6 and 7 million dollars on the state system. A large per cent of this will be spent on earthwork and culverts as very little hard surface road construction is contemplated at this time, it being the policy of the department to bring as much as possible for the state system to an established grade with drainage before proceeding with the hard surfacing.

W. V. Buck, Topeka, Kan., is state highway engineer.

West South Central States

Arkansas

The state highway completed in 1925 included 60 miles of 18 ft. 9 in. by 6 in. by 9 in. (Bates type) plain concrete, 60 miles of 18 ft. bituminous concrete, 24 miles of 16 ft. bituminous macadam, and 700 miles of 16 to 18 ft. 6 in. compacted gravel surface. In addition 230 miles of uncompleted gravel road and 325 miles of uncompleted graded road were carried over to 1926.

The new highway work for 1926 calls for a proposed expenditure of $7,000,000.

R. C. Limerick, Little Rock, Ark., is state highway engineer.

Oklahoma

The state highway completed in 1926 included 120 miles of plain concrete pavement, 2 miles of reinforced concrete pavement, 12 miles of brick, 18 miles of bituminous concrete, 22 miles of bituminous macadam, 52 miles of gravel road, 20 miles of sand-clay and 250 miles of graded and drained road. Only a very small amount of uncompleted work was carried over to 1926.

The new highway work proposed for 1926 reaches a total expenditure of $5,750,000 and includes 150 miles of concrete pavement, 300 miles of grading, and 50 miles of other types of pavement. In addition it is proposed to expend $1,750,000 for bridges work and $2,000,000 for maintenance.

John Marshall Page, Oklahoma City, Okla., is state highway Engineer.

Louisiana

During 1925 approximately 600 miles of state highway costing $6,200,000 were completed. About 650 miles estimated to cost $7,000,000 were placed under construction. In 1926 it is expected to build about 700 miles at a cost about $9,000,000.

Walter B. Robert, Baton Rouge, La., is state highway engineer.

Texas

During the past year activity along construction lines has been exceedingly heavy. During this period contracts were awarded, providing for the improvement of 916.29 miles of highways, and four bridge projects. These contracts provide for the expenditure of approximately $11,994,404, and will cover the construction of 79.93 miles of concrete paved roads, 1.06 miles of brick pavement, 215.48 miles of asphalt or bituminous macadam, 88.69 miles of gravel and macadam, 76.26 miles of shell and caliche, 454.87 miles of grading and drainage structures, and five exclusively bridge projects. The contracts for grading and drainage structures are for the first unit of the projects, and on these the surfacing will be constructed as soon as the grade has had ample time to become thoroughly consolidated, and when finances are available. In nearly all cases, however, funds are available, or will be when the time is opportune for the construction of the surfacing. Of the contracts let for grading and drainage structures, approximately 80 per cent of the mileage will be surfaced with a high type of pavement, it being the policy of the Texas State Highway Commission to construct its highways for permanence wherever possible.

It is estimated that approximately $20,000,000 will be expended on state highways during 1926, and a large percentage will call for high type pavements. The proposed work includes five or six large bridge projects which will involve an expenditure of approximately $1,600,000.

There are approximately 18,000 miles of state highways in Texas, of which approximately 12,000 miles are on the federal aid, or 7 per cent system, and since the creation of the state highway department in 1917, approximately 8,000 miles have been completed. During 1925 the following has been completed, which shows the mileage, type and cost.

Projects Completed During 1925

Type	Mileage	Cost
Concrete	88.72	$2,332,780
Bituminous on Concrete	9.65	295,302
Brick on Macadam	13.40	477,760
Brick on Concrete	7.28	140,329
Bituminous on Macadam or Gravel	198.16	2,512,308
Gravel and Macadam	440.99	4,747,401
Shell, Caliche and Sand Clay	85.49	912,232
Grading and Dr. Struct.	276.98	1,958,388
Bridge (Number 11)		526,727
Total	1,121.17	$14,103,286

The average unit bidding prices on 1925 highway work in Texas were as follows:

Unclassified Roadway Excavation	$ .17
Common Roadway Excavation	.20
Solid Rock Roadway Excavation	1.25
Dry Channel Excavation	.20
Wet Channel Excavation	.70
Excavation for Culverts, Class "A"	.70
Excavation for Culverts, Class "B"	1.00
Excavation for Culverts, Class "C"	3.00
Excavation for Bridges, Class "A"	1.00
Excavation for Bridges, Class "B"	2.00
Excavation for Bridges, Class "C"	6.00
Borrow	.17
Stripping Material Pits	.17
Over-haul	.04
Road Grader Work	6.00
Sub-base complete in place	
Shell furnished, exclusive of freight, etc.	.85
Crushing and Screening	1.40
Extra Rolling Base and Surface Courses	3.50
Sprinkling	2.50
Water hauled additional mile	1.50
Material hauled additional quarter	.07
Gravel Base Course	.47
Crusher Run Broken Stone furnished	1.30
Standard Gravel Surface Course complete in place	.50
Double Bit. Surf. Treatment complete in place	.30
Triple Bit. Surf. Treatment complete in place	.48
Bituminous Macadam Surf. Course com. in place	1.10
Two Course Limestone Rock Asphalt Surface Course	.56
Sheet Asphalt Pavement complete in place	1.65
Concrete Pavement complete in place	2.35
Reinforcing Steel for Pavements complete in place	.05
Untreated Bridge Timber complete in place	80.00
Treated Timber complete in place	110.00
Class "A" Concrete complete in place	20.50
Class "B" Concrete complete in place	20.00
Class "C" Concrete complete in place	20.00
Class "D" Concrete complete in place	23.00
Reinforcing Steel (Structures) complete in place	.05
Structural Steel complete in place	.085
Treated Timber Piling complete in place	1.10
Precase Concrete Piling complete in place	5.00
Wire Cable Guard Railing complete in place	.60
Wood Guard Railing complete in place	.50
Concrete Railing for Structures, Type "C" complete in place	2.20
Concrete Railing for Structures, Type "D" complete in place	2.50

R. J. Hank, Austin, Tex., is state highway engineer.

Mountain States

Montana

The state highway completed in 1925 includes 100 miles of 15 ft. wide, 8 in. thick, gravel road, at an average cost of $7,000 per mile. The uncompleted work carried over to 1926 comprised 30 miles of gravel road.

It is proposed to construct 100 miles of gravel road in 1926 at an estimated cost of about $800,000.

H. W. Holmes, Helena, Mont., is state highway engineer.

Idaho

The total mileage of state highway completed in 1925 amounts to 104.2, and on 98.8 miles of this grading and draining was done in addition to the surfacing. The total mileage carried over to 1926 was 120.2 leaving 7.87 miles that were graded and drained only (earth road). Some details of the 1925 work are given in the following tables:

Idaho State Highways Completed in 1925

	Miles	Av. Width Surface ft.	Thickness In.	Av. Cost Per Mile
Concrete Plain	11.45	18	6	$22,869
Macadam Water Bound	92.72	16	6	4,330
Graded and Drained	98.82	24	....	8,089

Uncompleted Work Carried Over to 1926

Type	Cost Per Mile	Miles
Grading and Draining	$ 9,204.32	128.10
Water Bound Macadam	3,164.20	106.59
Bituminous Concrete	22,072.60	13.64

The average unit costs on the 1925 work were as follows:

Average Unit Costs on 1925 Work

Solid rock, $1.16 per cu. yd.
Loose rock, $0.50 per cu. yd.
Earth, $.28 per cu. yd.
Class "A" concrete, $28.34 per cu. yd.
Class "B" concrete, $27.06 per cu. yd.
Reinforcing steel, 0.065 per lb.
Hand placed rip rap, $3.50 per cu. yd.
Loose rip rap, $2.44 per cu. yd.
Guard rail, 0.78 per lin. ft.
Crushed rock or gravel surfacing, $1.66 per cu. yd.
Plain concrete pavement, $1.84 per sq. yd.
Bituminous concrete pavement $1.67 per sq. yd.
Pavement sub-grade preparation, $.047 per sq. yd.
Gravel sub-base for pavement, $1.50 per cu. yd.
Crushed gravel shoulders, $1.85 per cu. yd.
Hauling and placing galvanized pipe culverts:
12 in.—27 cts.
15 in.—35 cts.
18 in.—50 cts.
24 in.—64 cts.
30 in.—$1.38
36 in.—$1.40
Hauling and placing concrete culvert pipe:
12 in.—43 cts.
18 in.—55 cts.
24 in.—55 cts.
30 in.—75 cts.
36 in.—$1.25

In 1926 it is proposed to build 28 miles of earth road and to pave 81 miles. In the table below the probable expenditure for grading and draining is the total for this class of work on all types of surfacing:

New Idaho Highway Work Proposed for 1926

Type	Miles Miles	Probable Expenditure Expenditure
Water Bound Macadam	49.0	187,224
Concrete Paving	6.4	145,620
Bituminous Concrete Paving	25.6	529,276

H. W. Gregory, Boise, Idaho, is director of highways.

Colorado

Federal aid state highway projects completed in 1925 included 28.1 miles of concrete pavement, 1.9 miles bituminous concrete, 84.6 miles gravel, 8.4 miles sand-clay and 3 miles of graded roads. In addition structural projects costing $117,500 were completed.

The uncompleted contracted federal projects carried over to 1926 included 16½ miles of concrete road, 54.4 miles gravel surface, 67.8 miles graded road, and $92,200 of structural projects.

Details of the completed work follow:

State Highway Completed in 1925
(Federal Aid Projects)

	Miles	Av. Width Surface Ft.	Thickness In.	Av. Cost Per Mile
Concrete, Plain	28.1	18	9–6½–9	$35,000
Bituminous Concrete	1.9	18	7*	43,000
Gravel	84.6	16–18	6	13,500
Sand-Clay	8.4	18	2 to 6	6,200

*Concrete Base 5 to 7 in; top 2 in.

The budget for next year is not yet completed, so it is impossible to give the 1926 construction program at this time.

L. D. Blauvelt, Denver, Colo., is state highway engineer.

New Mexico

A total of 78.7 miles of federal aid state highway was completed in 1925. In addition 45.8 miles of uncompleted federal aid units were carried over to 1926. Details are given in the accompanying tables.

Federal Aid State Highway Completed in New Mexico in 1925

Type	Miles	Av. Width Surface ft.	Thickness In.	Av. Cost Per Mile
Concrete Plain	4.54	18	6-9x	$36,456
Gravel	61.255	16	6	10,138
Graded and Drained	12.98	24	....	6,586

xMarycopa type. xCompacted.

Uncompleted Work Carried Over to 1926

Type	Miles	Estimated Cost To Complete
Concrete Plain	3.05	$108,450
Gravel	35.03	306,690
Graded	7.74	265,000
xBridges	——	264,200
	45.82	$944,340

xSeparate Contracts.

The average unit bid prices on the 1925 work were as follows:

Average Contract Unit Prices—1925

Item	Unit	Average Unit Bid
Class "1" Excavation	Cu. Yd.	$ .296
Class "2" Excavation	Cu. Yd.	.825
Class "3" Excavation	Cu. Yd.	2.17
Class "1" Borrow	Cu. Yd.	.265
Overhaul	Sta. Yd.	.045
Clearing and Grubbing, Overhaul	Acre	30.00
Class "A" Concrete	Cu. Yd.	26.16
Class "B" Concrete	Cu. Yd.	25.61
Concrete 1:2:3 (Structures)	Cu. Yd.	20.70
Mortar Rubble Masonry	Cu. Yd.	10.67
Rip Rap	Cu. Yd.	2.50
Grouted Cobble Stone Apron	Cu. Yd.	10.00
Spillway Base Course	Cu. Yd.	2.17
Concrete Pavement 1:2:3	Cu. Yd.	14.19
Two Course Crushed Rock Surfacing	Cu. Yd.	3.37
Two Course Crushed Caliche Surfacing	Cu. Yd.	1.85
One Course Gravel Surfacing	Cu. Yd.	1.70
Gravel Surfacing (Bridge Floors)	Cu. Yd.	2.89
Clay or Caliche Plating	Cu. Yd	.77
18 in. diam. 16 Ga. C. M. C	Lin. Ft.	2.45
24 in. diam. 14 Ga. C. M. C	Lin. Ft.	3.09
30 in. diam. 14 Ga. C. M. C	Lin. Ft.	3.71
36 in. diam. 14 Ga. C. M. C	Lin. Ft.	3.47
24 in. diam. Rein. Conc. Pipe	Lin. Ft.	3.50
30 in. diam. Rein. Conc. Pipe	Lin. Ft.	5.00
Structural Steel	Tons	157.67
Treated Timb. Superst	M. B. M.	151.75
Treated Timb. Substruct	M. B. M.	149.75
Timber Superstructure	M. B. M.	102.50
Wooden Piling	Lin. Ft.	1.65
Reinforcing Nars	Lbs.	.074
Exp. Metal Reinforcing	Sq.Ft.	.035
Asphalt Exp. Joint	Lin. Ft.	.127
Concrete Masonary Excavation	Cu. Yd.	4.77
Wet Excavation	Cu. Yd.	5.00
Protection Ditches & Dikes	Lin. Ft.	.137
Moving Fence	Lin. Ft.	.032
Woven Wire Guard Fence	Lin. Ft.	.92
Concrete Headgate	Each	30.00
Gate and Cattle Guard	Each	385.00

The tentative program for new federal aid highway work for 1926 calls for a probable expenditure of $1,991,000. The types and mileage are as follows:

Tentative Program New Highway Work (Federal Aid) Proposed for 1926

Type	Miles	Probable Expenditure
Concrete, Plain	5.45	$ 203,309
Bituminous Macadam	16.06	432,000
Gravel	41.93	553,622
Graded and Drained	36.47	406,086
*Bridges		413,656
Total	99.91	$2,008,713

*Separate Contracts

James A. French, Santa Fe, N. Mex., is state highway engineer.

Arizona

The state highway completed in 1925 comprises 1½ miles of plain concrete, 99.1 miles of gravel road, 19.4 miles of graded and drained road, 7½ miles of bituminous concrete. Approximately 15 miles of the gravel surface roads in Forest Reserves are being constructed by the U. S. Bureau of Public Roads. One of these Forest Reserve jobs of 23½ miles is now being surfaced with bituminous macadam, with 1 mile complete. Details of the state highway work completed in 1925 follow:

Arizona State Highway Completed in 1925

	Miles	Av. Width Surface Ft.	Thickness In.	Av. Cost Per Mile
Concrete, plain	1.5	18	9–6–9	$22,000
Bituminous Concrete	7.48	18	6	22,000
Gravel	69.14	18*	6	....
Graded and Drained	19.44	24	....	....

*Feathered

The uncompleted work carried over to 1926 includes 13.2 miles of gravel surface and 12.6 miles of graded and drained road.

The new highway work proposed for 1926 calls for a total expenditure of $3,200,000 and includes 7 miles of paving, 100 miles of gravel surface, and 40 miles of graded and drained road. In addition it is expected to build one bridge costing about $300,000 and various smaller structures.

W. C. Lefebvre, Phoenix, Ariz., is state highway engineer.

Utah

The total mileage of Federal aid projects completed to Dec. 1, 1925, was 116.65 and the approximate total cost was $1,572,606. The

Federal aid projects under construction and held over to 1926 totaled 105 miles; the approximate total cost being $987,125. The following tables show the status on Dec. 1, 1925:

Utah Federal Aid Projects Completed 1925

No.	Name	Type	Cost	Mileage
7A	LaSal Junction—Big Wash	Gravel (Type N)	$ 52,948	5.06
*17B	Chicken Creek—Millard County Line	Gravel (Type N)	98,963	13.87
*31A	Riverdale Viaduct Paving	Bituminous Concrete	14,441	0.47
*49	Gogorza—Salt Lake County Line	Gravel	40,448	3.07
*51A	Knolls—Wendover	Gravel	379,396	41.40
*71	Black Ridge and Upper Ash Cr. Bridge	Gravel and Conc. Arch	170,093	12.80
*72A	Layton—Clearfield (Resurfacing old)	Bit. Concrete and	148,480	† 2.00
77A	16-ft. Concrete	Concrete		‡ 2.11
78	Echo—Emory	Gravel (Type N)	191,564	11.40
*81A 1-2	Chase—Bear River City and	Gravel (Type N)		
*82A	Malad River and Bear Bridges	and Conc. Bridges	152,374	5.10
107A	Wasatch County Line—Bridal Veil Falls	Gravel (Type N)	52,862	3.40
*55A 1-2	Uintah River Bridge	Steel Truss	41,646	
*59	Fairview—Mt. Pleasant	Gravel (Type N)	55,231	5.00
	Richfield—Elsinore	Gravel (Type N)	53,806	5.53
*60A 1	Cedar City Paving	Concrete	35,673	1.13
*63A 1, 2, 3	Anderson's Ranch—Toquerville and Bridge	Gravel (Type S)	50,336	2.83
	Manderfield Hill	Gravel (Type S)	12,657	0.49
*65A	Mt. Pleasant City	Gravel and Concrete		** 0.49
	*Held over from 1924.		21,681	† 0.50
		Approximate Total Cost	$1,572,606	**110.44 † 3.63 ‡ 2.58
		Total Mileage		116.65

** Gravel, † Concrete, ‡ Bituminous Concrete.

Utah Federal Aid Projects Under Construction—Not Completed—Held Over 1926

No.	Name	Type	Cost	Mileage
51B	Timpie—Knolls 50%	Gravel (Type N)	$249,593	35.33
60A-2	Echo Underpass 10%	Gravel (Type N)	30,000	
63B	Bear River City—Tremonton 60%	Gravel (Type N)	72,185	9.14
66A	Parowan—Winn Hollow 94%	Gravel (Type N)	93,943	9.57
67	Scipio—Holden 95%	Gravel (Type N)	85,823	12.04
68A	Cove Fort—Dog Valley 85%	Gravel (Type N)	50,134	6.50
73A	Red Narrows—Detour 0%	Gravel (Type N)	128,060	9.40
81B	Rockville—Zion National Park 0%	Gravel (Type N)	119,145	6.40
94A	Myton—Antelope 45%	Gravel (Type N)	96,730	9.28
98A	Wildcat——Millard County Line 65%	Gravel (Type N)	40,456	5.84
98B	Cove Fort—Beaver County Line 98%	Gravel (Type N)	21,151	2.14
	% shown indicates per cent complete.	Approximate Total Cost	$987,125	105.05

The Federal aid projects proposed for construction in 1926 cover 123 miles of gravel road. The approximate total cost is $2,183,673. The following table gives some details:

Utah Federal Aid Projects Proposed for Construction 1926

No.	Name	Type	Cost		Mileage
10C	Ft. Duchesne—Vernal (Bridges)	6-30—1-50—1-20—1-15	$ 25,000		
19D	Red Bridge—Garfield County	Gravel (Type N)	50,000		6.52
60B	Emory—Wahsatch	Gravel (Type N)	176,000		14.08
61A	Salina—Richfield	Gravel (Type N)	208,672		17.44
61B	Sevier River Bridge (Salina)	Concrete	20,000	75 ft.	
62A	Washington Ave.—Morgan County Line	Gravel	190,000		9.29
62B	Weber County Line—Mt. Green	Gravel	42,000		2.79
65B	Bridal Veil Falls—Olmstead	Gravel	100,000		4.00
73B	Detour Overhead (50% D. & R. G.)		20,000		
73C	Red Narrows Section (50% D. & R. G.)	Gravel	60,000		1.00
73D	Castella—Thistle ($40,000 D. & R. G.)	Gravel	190,000		6.93
74A	Grassy Trail Bridge	Steel Truss	35,000	100 ft.	
74B	Price—Woodside (Bridges)		25,000		
75A	Woodside—Green River Bridges		40,000		
76A	Echo—Coalville	Gravel	73,000		4.00
76B	Pace's Ranch—Wanship	Gravel	96,000		8.00
79A	St. George—North	Gravel	160,000		8.00
81C	Rockville—Grafton	Gravel	50,000		3.00
83A	Brigham City—Mantua (Box Elder Sec.)	Gravel and Bridge	20,000		0.50
94B	Antelope—Duchesne	Gravel and Bridge	140,000		10.00
94C	Myton—Roosevelt	Gravel and Bridge	130,000		9.5
100A	Green River—Floy Bridges		37,000		
101A	Thompson's—Cisco Bridges		40,000		
102A	Cisco—Colorado Line Bridges		40,000		
104A	Zion Park—Mt. Carmel	Gravel	216,000		18.00
		Approximate Total Cost	$2,183,672		123.05

Howard C. Means, Salt Lake City, Utah, is chief engineer, state highway commission.

Nevada

During 1925 the state highway completed included 2 miles of plain concrete, 188 miles of gravel surface, 15.6 miles of graded and drained road and 2 miles of bituminous concrete (Willite). The uncompleted work carried over to 1926 comprised 24 miles of gravel surface and 8 miles of grading. Details of the work completed in 1925 follow:

Nevada State Highway Completed in 1925

	Miles	Av. Width Surface Ft.	Thick-ness In.	Av. Cost Per Mile
Concrete, Plain	2.167	18	6	$43,000
Bituminous (Willite) Concrete	1.98	18	5	31,300
Gravel	188.44	15	5	8,148
Graded and Drained	15.804			13,000

The new highway work proposed for 1926 includes 100 miles of gravel surface. The probable expenditure is $1,000,000.

Geo. W. Borden, Nevada City, Nev., is state highway engineer.

Wyoming

State Highway completed in 1925 comprised 80.9 miles of 18 ft. 6 in. deep, gravel surface costing $10,500 per mile, including grading and bridges; and 121.5 miles of graded and drained road costing $6,000 per mile, including drainage structure. The uncompleted work carried over to 1926 included 98.7 miles of gravel road and 71.7 miles of graded and drained road.

The highway program for 1926 calls for 75 miles of gravel surfacing at a proposed cost of $300,000 and 125 miles of graded and drained road at a cost of $750,000.

Z. E. Sevison, Cheyenne, Wyo., is state highway engineer.

Pacific Coast States

Washington

The state highway completed in 1925 comprised 64 miles of plain concrete, 90 miles of gravel or crushed rock and 56 miles of graded and drained road. Details of this work follow:

Washington State Highway Completed in 1925

	Miles	Av. Width Surface Ft.	Thick-ness In.	Av. Cost Per Mile
Concrete Plain	64	18–20	9–6½–9	*$28,500
Gravel or Cr. Rock	90	14	7	4,000
Graded and Drained	56	....		5,000 to 25,000

*Surface only.

The uncompleted work carried over to 1926 included 47 miles of gravel or crushed rock road, and 66 miles of graded or drained road.

The new highway work planned for 1926 calls for a proposed expenditure of $6,500,000. It includes 32 miles of concrete pavement, 200 miles of grading and surfacing with crushed rock or gravel and 13 bridges.

J. W. Hoover, Olympia, Wash., is state highway engineer.

Oregon

A total of over 323 miles of state highway was completed in 1925 and in addition 169 miles of uncompleted work were carried over to 1926. The following table gives details:

Oregon State Highway Completed in 1925

	Miles	Av. Width Surface Ft.	Thick-ness In.	Av. Cost Per Mile
Concrete, Plain	7.6	18	9–7–9	$25,000
Bituminous Concrete	0.6	18	5	25,000
Gravel and Broken Stone	140	16	8	6,000
Graded and Drained	175	24	..	12,000

Uncompleted Work Carried Over to 1926

Type	Miles
Gravel and Broken Stone	60
Grading	100
Concrete Paving	9

Roy A. Klein, Salem, Ore., is state highway engineer.

California

State highway completed in 1925 amounted to 39 miles of plain concrete including "second story work," 23 miles of asphaltic concrete surfacing, 77 miles of graded and graveled road and 28 miles of graded and drained road.

The uncompleted work carried over to 1926 included 11 miles of grading and drained road, 23 miles of plain concrete including "second story work," 10 miles of asphalt concrete surfacing, and 7 miles of asphalt macadam.

Details of the state highway work completed in 1925 follow:

California State Highway Completed in 1925

	Miles	Av. Width Surface Ft.	Thick-ness In.	Av. Cost Per Mile
Concrete Plain	39	20	6	$31,000
Asphalt Concrete Surfacing	23	15–20	2–5	27,000
Gravel and Graded	77	20	6	35,000
Graded and Drained	28	24–26	..	24,000

The program for 1926 work is not available at this time.

Robert M. Morton, Sacramento, Calif., is state highway engineer.

State Highway Reports Received Too Late for Inclusion in Regular Grouping

Ohio

It is estimated that this state completed in 1925 about 450 miles of paved road at a cost of $13,000,000, also 700 miles of other roads. It is not possible, at this time to give program for 1926, but it is expected that about 500 miles of highway will be paved.

Tennessee

The state highway construction completed in 1925 included 41.6 miles reinforced concrete pavement; 14.6 miles rock asphalt; 21.8 miles bituminous concrete; 46 miles bituminous macadam; 12.9 miles waterbound macadam; 52.7 miles chert or gravel; 20 miles base only; 43.3 miles slag and miscellaneous pavements; 6 miles surface treatment; 149.9 miles grading and drainage. The total expenditures in 1925 were $14,399,000 of which $9,579,000 was for construction and $4,009,000 for maintenance. The expenditures for 1926 will be on about same ratio as for 1925, C. N. Bass, Nashville, Tenn., is acting State Highway Commissioner.

Tar Surface Treatment of Gravel Roads

General Methods Described in Paper Presented at Last Annual Meeting of Canadian Good Roads Association

By JOHN S. CRANDALL
Consulting Engineer, The Barrett Company

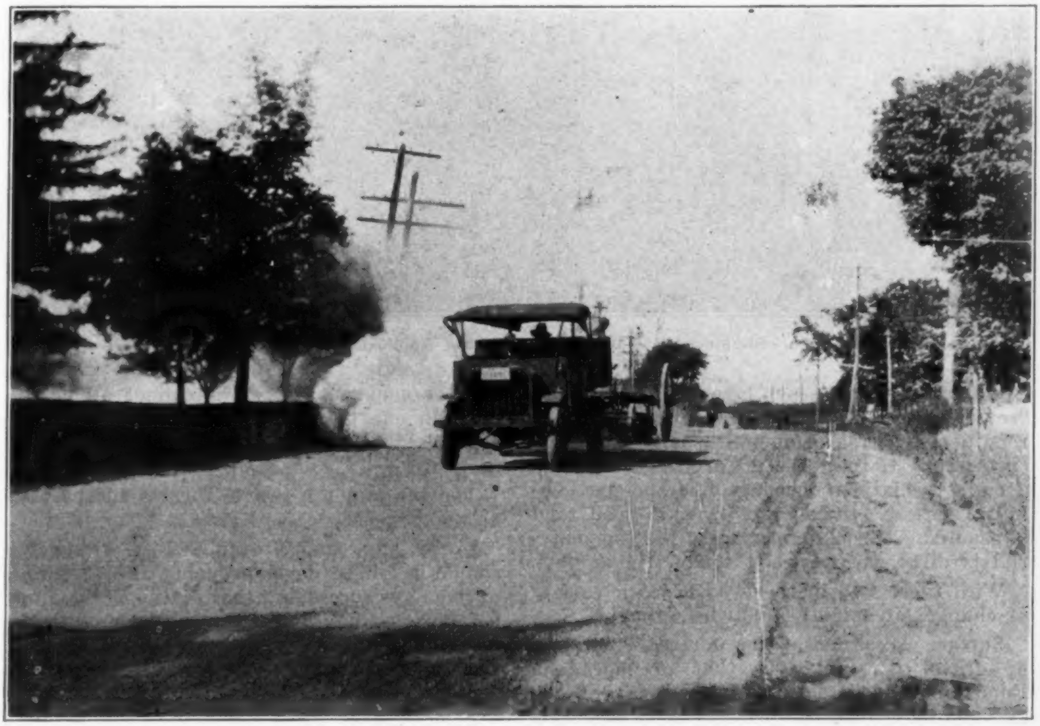
The word "gravel" is so all-inclusive that it is difficult to define it in such terms that everyone will agree. Gravel roads may vary from those which are sand-clay to roads which approach water-bound macadam. During the past five years experiments in bituminous surface treatments have been tried on all varieties—sometimes with great success, frequently with gratifying results, and once in a while with either indifferent results or out-and-out failure.

While we have not yet reached the stage where we can infallibly predict what will happen, we are able, in most instances, to do so. We know that certain types of gravel respond best to definite methods of treatment. That certain other types require either modification of the methods usable on the other types, or radically different methods. Sometimes the character of the gravel in a road changes as we progress down the road, and we must change our treatment accordingly. This will happen if gravel from different sources is used in the same road, although it may happen when all material comes from the same gravel bank or pit if this source of supply does not run uniformly.

Two General Methods.—Digesting all of the articles recently published, and examining in person the various jobs, the conclusion is reached that there are two general methods in use today, with a number of interesting modifications. These two methods, for want of better names may be called

(a) surface treatment
(b) mulch treatment

The results sought are identical: the means of obtaining the results are quite different.



Sweeping Preliminary to Applying Surface Treatment on Road East of Madison, Wis.

What we aim at is the formation of a waterproof dustless coating for a reasonable price.

If we have a firm, hard gravel road, (free from a top layer of loose gravel), built of aggregate that tends to set up after a rain with no disposition to immediately start to ravel when the rain stops, with no excess of clay, with a fair amount of pebbles of over ½ in. size and less than 2 in., then we may, in all reason, give such a road a tar surface treatment with every expectation of success.

If we have a firm gravel road which has a loose top layer of gravel of perhaps an inch or two thickness, and which layer refuses to stay "set up" after a rain, then we may give that road a mulch treatment and usually it will be successful. If the loose material is clean, and enough tar is introduced to bind the particles into a sort of "gravel mix" then a good road is assured. If, on the contrary, the top material is dirty, then a good road is impossible.

With these two methods as bases a variety of changes in minutae may be wrought.

Surface Treatment.—The surface treatment of gravel is similar to that of macadam. Fundamentally, it consists in sweeping off the dirt and loose material prior to the application of the tar. But with the spraying of the tar the similarity often ceases. There is a resistance to the penetration of a bituminous material when applied to macadam. Most gravels, however, show no such resistance, but rather exhibit a decided tendency to suck up the light tar much as a blotter takes up ink. I have often seen a treatment of tar over gravel lose its sheen in 15 minutes, the surface of the treated gravel turning to a dead brownish black. On examining the road the tar would be found to have penetrated to the depth of an inch. Such a gravel should be fed all the tar it will absorb, which may be as much as a gallon per square yard. This cannot all be applied in one treatment. Where there is this decided absorptive tendency no "cover" is needed.

Shaping Loose Material After First Application of Tar

The tar and the gravel form a most desirable road crust.

If, by any chance, ruts, waves or bunches should begin to develop during the first four or five days succeeding the treatment they may be and must be immediately removed with the blade grader or a drag. After about five days the tar has completely "set" and the surface should not be disturbed.

Some gravel roads act more like macadam when surface treated, and do not readily ab-

sorb the tar. Probably it will be found in such cases that a ½ gal. treatment is all that may be applied without waste. And this must, perhaps, be covered with clean pea-gravel or stone chips to prevent picking up by traffic. It is always best to apply two light treatments in lieu of one heavy dose. At least a day should elapse between applications.

Uncommon sense must be exercised about the preliminary sweeping of a gravel road of this type. The surface must, if possible, show the clean surface of the individual pebbles, yet the sweeping must be done so that the body of the road and even the surface is not disturbed. This brings us to the fact that a newly built gravel road cannot be successfully surface-treated. The gravel should be in place at least six months before endeavoring to treat it, for consolidation is slow and weak spots must be searched out by traffic. Only after it is firm should it be treated.

A mixture of sand and Tarvia B, using 17 gal. of Tarvia B per cubic yard of sand, is useful for patching shallow holes. This mix may be stored away for subsequent use.

Mulch Method.—The mulch treatment is quite different from what has been described. It consists in mixing tar with loose gravel in place on the road. The method is as follows:

Level off the loose material with a grader.

Apply approximately ⅓ gal. of Tarvia B over the loose gravel.

Immediately move the loose tar treated material to one side of the road.

Treat the exposed hard surface with approximately ¼ gal. per square yard of Tarvia B.

Immediately move the loose material back over the wet Tarvia B and treat the hard surface on the other side with about ¼ gal. of Tarvia B.

Surface Treated Gravel Road East of Madison, Wis

Spread the loose material uniformly over the road and work smooth with the grader under traffic.

If after traffic has ironed the road smooth it is found that the surface is not water proof, then apply a seal coat of about ⅙ gal. per square yard with a pea gravel or coarse sand cover.

The following precautions are suggested:

Hold the first coat of tar on the loose material down to not more than ⅜ gal.

Insist on thoro mixing of the tar treated loose material moving it across the road two or more times if necessary.

Never use more than ⅓ gal. of tar on the solid material.

Use a grader or planer on the loose material as long as it can be operated. This will help to prevent waves. If the loose material appears to have too much tar in it, work in dry gravel with the grader.

Delay the seal coat until the road is solid under traffic. Usually this will take from ten days to two weeks. Keep the seal coat light and omit it altogether if the road clearly shows that it is not needed.

Discourage the use of sand for cover material unless mixed with pea gravel.

If in doubt use too little tar rather than too much. Holes and raveled spots are more easily fixed than waves.

Do not use the tar-sand mix for deep patches unless applied in thin layers.

The two methods given above are the foundation for all the different methods that have recently appeared. In general, most gravels may be treated successfully by either one or the other method. If, however, success is not obtained then some modification must be introduced.

It should be kept in mind that the cost of these treatments is usually not much more than the cost of replacing the gravel that is worn or blown away on the average untreated road. There is not an unlimited amount of road building gravel and some localities have almost reached the end of their supply. Therefore a tar treatment not only preserves the road intact, but conserves the gravel supply.

Reinforcement in Concrete Roads

Summary of Conclusions of Report on Investigation of Economic Value Presented at Fifth Annual Meeting of Highway Research Board

By C. A. HOGENTOGLER
Highway Research Board, National Research Council

The amount of cracking and subsequent disintegrating is a function of time; thus, the rate of cracking is a measure of the life of the pavement.

The data show that steel reinforcement reduced the rate of cracking and thus increased the life of the pavement. This applies both to concrete pavements and other pavements laid upon a concrete base.

Crack reduction is more conomically accomplished by the use of steel reinforcement than by additional thickness of concrete.

A greater reduction was afforded by small steel members closely spaced than by larger members wider spaced.

Increasing weight of mesh from 25 to 56 lb. per 100 sq. ft. considerably reduced cracking.

Mesh reinforcement, 25 to 56 lb. per 100 sq. ft., reduced cracks 35 to 70 per cent in pavements of like thickness.

Mesh reinforcement, 25 to 56 lb. per 100 sq. ft. and bar mat reinforcement 64 lb. per 100 sq. ft.—25 per cent longitudinal—reduced cracks more than one additional inch of concrete, but one additional inch of concrete reduced cracks more than bars (42 to 48 lb. per 100 sq. ft.) placed transversely only.

With good crushed stone aggregate, 56 lb. per 100 sq. ft. mesh reinforcement, or 170 lb. per 100 sq. ft. bar reinforcement, 50 per cent each way, caused a reduction in combined transverse and longitudinal cracks equal to that indicated for 2 in. additional center thickness.

Mesh reinforcement of 38 lb. per 100 sq. ft. has been effective for a thin layer of concrete laid as resurfacing upon an old concrete road.

One additional inch of edge thickness reduced corner cracks more than mesh reinforcement 25 to 56 lb. per 100 sq. ft., or ⅜ to ¾ in. bar reinforcement, but progressive destruction following the appearance of corner cracks was arrested by steel reinforcement.

All types of steel reinforcement across cracks tended to hold together fractured slabs.

Bar reinforcement across transverse joint, without proper provision for slippage and clearance, resulted in breakage and subsequent expensive repairs.

For long slabs, 75 to 100 ft. or over, edge bar reinforcement with continuous bond caused corner cracks if the area of steel exceeded ¼ sq. in.

A remarkable agreement was found to exist between results of observations on roads in service and results furnished by a wide range of experimentl roads and laboratory tests.

Sales of Reclaimed Land to Pay Cost of City Improvement.—The lake front on Lake Pontchartrain at New Orleans, La., is to be improved. 81,000,000 sq. ft. of land is to be reclaimed, 36,000,000 of which will be sold as home sites direct to the people by the Levee Board. On the remaining acres will be laid out new parks and boulevards. The proceeds from the sale of part of the land is expected to pay for the cost of the improvement.

Motor Vehicle Taxes.—The gross income in 1924 of all the states from motor vehicle fees and gasoline taxes was $304,467,082.

Chicago Road Convention and Show

Information Regarding the Annual Meeting of the American Road Builders Association and Exhibits of Machinery, Methods and Materials for the Construction and Maintenance of Highways

The 23rd annual convention and road show of the American Road Builders Association, which is to be held January 11-15 at Chicago, promises to be the largest and most successful gathering of its kind ever held. Indications point to an attendance of over 30,000 engineers, contractors, officials and others interested in the highway industry. The meetings of the convention will be held at the Congress Hotel and will cover the three days Jan. 12, 13 and 14. The Road Show, as in previous years, will be held in the Coliseum and adjoining buildings and will extend from Jan. 11 to 15, inclusive.

The Convention

The program of the convention is divided into two sections: one especially interesting to highway engineers, and the other to highway contractors. The meetings have been arranged to convene at the same hour for the discussion of engineering problems and constructors' problems. Separate meetings will be the rule except for a general session which opens the convention, a joint session with the National Highway Traffic Association and the concluding session, which is also a general session.

A special effort has been made by the program committee to provide a co-ordinated and well balanced program which contains topics of interest to all parts of the diversified membership. Discussion of the several subjects is being emphasized rather than the reading of long papers. The speaker will ordinarily be permitted to use only 15 or 20 minutes for a presentation of the high spots (he may prepare a paper of unlimited length for publication) and the remaining time—30 to 45 minutes—will be devoted to discussion from the floor.

Official Program.—The program of the convention follows:

TUESDAY, JANUARY 12, 1926

GENERAL SESSION

Tuesday Morning at 10:00

Presiding—Mr. William H. Connell, President, A. R. B. A., Engineering Executive and Acting Secretary of Highways, Pennsylvania Department of Highways.

Opening Address by the President.

Addresses by:

Honorable Len Small, Governor of Illinois.
Honorable Wm. E. Dever, Mayor of Chicago.
C. H. Markham, President, Illinois Central Railroad.
One of the Leading Financial Men of the Country.

TUESDAY, JANUARY 12, 1926

ENGINEERING PROBLEMS

Tuesday Afternoon at 2:00

Presiding—Mr. Frank F. Rogers, State Highway Commissioner of Michigan.

General Subject—Financing and Locating Highways

2:00 **Financing Highways** (Federal, State, County and City)—Thos. H. McDonald, Chief, Bureau of Public Roads, U. S. Department of Agriculture.

3:00 **Locating Rural Highways**
W. W. Crosby, Location Engineer, Pennsylvania Department of Highways.

4:00 **Arterial Street Planning in Cities**
Eugene S. Taylor, Manager, Chicago Plan Commission.

5:00 **Activities of Highway Research Board of the National Research Council**
Charles M. Upham, Director.

CONSTRUCTORS' PROBLEMS

Tuesday Afternoon at 2:00

Presiding—Mr. James Cameron, President, Illinois Association Highway and Municipal Contractors; Secretary, Cameron, Joyce and Company, Keokuk, Iowa.

General Subject—Making the Contracting Business Pay

2:00 **Investigation of Projects on Which you Bid**
N. F. Helmers, President, Siems, Helmers and Schaffner, St. Paul, Minnesota.

3:00 **Estimating the Job**
A. R. Hirst, Chief Engineer, American Vibrolithic Corporation, Des Moines, Iowa.

3:45 **Prosecuting the Work and Keeping Intelligent Cost Records**
W. R. Smith, President, The Lane Construction Company, Meriden, Connecticut.

4:30 **Qualifications of the Contractor**
Col. George B. Walbridge, President, Walbridge-Aldinger Co., Detroit, Michigan; President, Associated General Contractors of America.

WEDNESDAY, JANUARY 13, 1926

GENERAL SESSION

Joint Meeting with the
National Highway Traffic Association

Wednesday Morning at 10:00

Presiding—Mr. A. H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan; President, National Highway Traffic Association.

General Subject—Traffic

10:00 **Measures for the Safety and Convenience of the Traveling Public** (Signs, Policing, Traffic Lines, etc.)
Col. Sidney D. Waldron, Detroit, Michigan; Member Executive Committee, American Automobile Association.

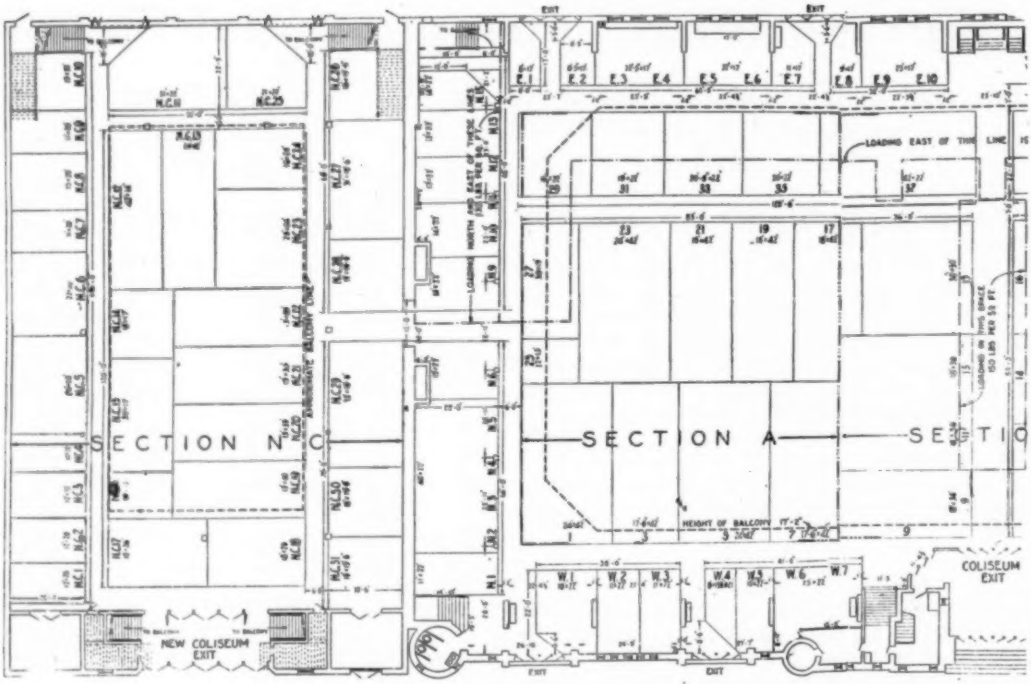
11:00 **Future Developments of the Motor Vehicle**
C. F. Kettering, General Motors Research Corporation.

12:00 **Possibilities of Motor Vehicle Transportation as a Supplement to Railroad Operation**
Officer of a Steam Railroad System.

Wednesday Evening at 7:00

Road Builders' Annual Banquet, Gold Room, Congress Hotel

Principal Speaker, Chas. M. Schwab.



Plan of Main Floors of the Coliseum, the Annex, the New Coliseum and the

WEDNESDAY, JANUARY 13, 1926

ENGINEERING PROBLEMS

Wednesday Afternoon at 2:00

Presiding—Mr. George W. Borden, State Highway Engineer of Nevada.

General Subject—Construction

2:00 **Governing Factors in Selection of Durable Types of City Pavements**
C. M. Pinckney, Chief Engineer, Borough of Manhattan, New York City.

3:00 **Recent Developments in Concrete Paving Practice**
H. E. Surman, Engineer of Design, Division of Highways, Illinois Department of Public Works and Buildings.

4:00 **Recent Developments in Bituminous Paving Practice**
Harry McCahan Rex, Construction Engineer, North Carolina State Highway Commission.

CONSTRUCTORS' PROBLEMS

Wednesday Afternoon at 2:00

Presiding—Mr. W. F. Creighton, President, Foster and Creighton Co., Nashville, Tennessee.

General Subject—Practical Operating Methods

2:00 **Increased Costs Due to Improper Fine Grading Methods**
C. J. Moritz, Contractor, Effingham, Illinois.

2:45 **Relative Merits of Yard Handling of Materials With Derricks, Cranes, Conveyors, etc.**
Robert P. Petersen, Henry W. Horst Company, Rock Island, Illinois.

3:30 **Economics of Equipment Standardization**
Speaker not yet selected.

4:15 **How to Stop Cement Over-Run**
Robert E. O'Connor, J. C. O'Connor and Sons, Fort Wayne, Indiana.

BUSINESS MEETING

Wednesday Afternoon at 4:30

THURSDAY, JANUARY 14, 1926

ENGINEERING PROBLEMS

Thursday Morning at 10:00

Presiding—Mr. Paul D. Sargent, Chief Engineer, Maine Highway Department.

General Subject—Operation and Maintenance

10:00 **Snow Removal**
Victor T. Burton, State Highway Department, Lansing, Michigan.

11:00 **Gang vs. Caretaker Maintenance**
William H. Acheson, Division Engineer, New York State Department of Public Works.

12:00 **Surface Treatment of Various Types of Roads**
J. N. Mackall, Chief Engineer, Maryland Highway Department, Baltimore, Maryland.

CONSTRUCTORS' PROBLEMS

Thursday Morning at 10:00

Presiding—Mr. Edward McCrady, President, McCrady Brothers Company, Braddock, Pennsylvania.

General Subject—Enlarging the Contractors' Field

10:00 **Economic Reasons for Winter Letting of Road Work**
J. H. Mullen, Vice-President, Nelson, Mullen, Nelson, Inc., Minneapolis, Minnesota.

11:00 **Relations Between the General Contractor and Sub-Contractor**
C. E. Hair, President, Belmont Trucking Company, Terre Haute, Ind.

12:00 **Resurfacing and Maintenance Work as a Future Field for the Contractor**
George F. Schlesinger, Director of Highways and Public Works, Columbus, Ohio.

FINAL GENERAL SESSION

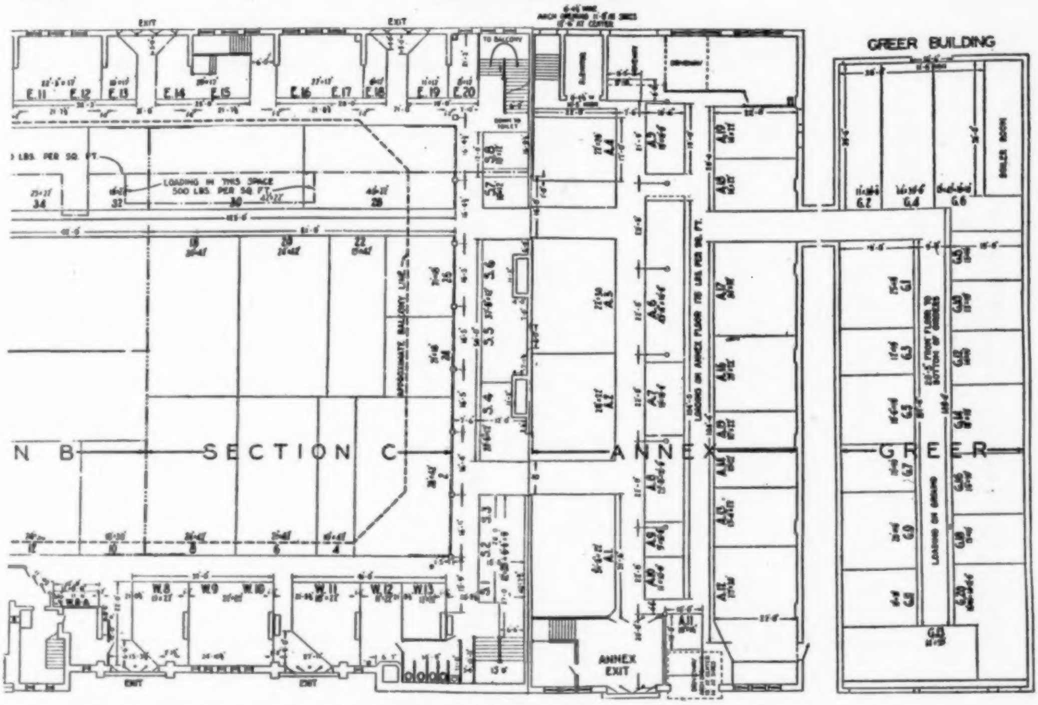
Thursday Afternoon at 2:00

Presiding—Mr. S. M. Williams, Vice-President, Autocar Sales and Service Company, Ardmore, Pennsylvania.

General Subject—The Contractor and the Engineer

2:00 **One-sided Clauses in Public Works Specifications**
General R. C. Marshall, Jr., General Manager of Associated General Contractors of America.

3:00 **Relations Between the Contractor and the Engineer**
C. M. Babcock, State Commissioner of Highways, St. Paul, Minnesota.



Greer Building, Showing Locations of Booths of Exhibitors at the Road Show.

The Road Show

Approximately 273 concerns have space at the road show. It undoubtedly will be the largest exhibition of road building machinery, equipment and supplies ever seen on display at one time. A list of the exhibitors, together with a brief outline of the nature of their exhibit when this was obtainable follows:

The Exhibitors at the 1926 Road Show

Adams & Co., J. D.—Booth 27. Adams adjustable leaning wheel graders; also continuous showing of educational motion pictures showing up-to-date and improved methods of building and maintaining earth, gravel, and stone roads, and of using graders on contract work. E. E. Christena in charge.

Ahlberg Bearing Co.—Booth N C B-48.

Ajax Wrench Corp.—Booth B R-58.

Alan Wood Iron & Steel Co.—Booth W B-19. Section of model bridge floor and railroad highway crossing, both constructed of "AW" diamond pattern rolled steel traffic friends. I. M. Smith, M. L. Wagner, in attendance.

American Bosch.—Booth N B-1. Magnetos, generators, starters, plugs, Ford and Fordson accessories. F. J. Bartella, E. S. Fraser, Wm. Seefeldt in attendance.

Amerian Castings Co.—Booth 32.

American Cement Machine Co.—Booth N C-29. New 1926 model one-two Bag Boss all steel mixer, 5 S Boss heavy duty tilter on cushion tires, Mandt shovel mounted on a Fordson for excavating and truck loading. O. G. Mandt, H. B. Hayden, E. G. Mandt, E. Jamison, D. J. Alston, C. J. Kirch in attendance.

American City.—Booth B R-29.Magazine

American Gas Accumulator Co.—Booth N C B-27 and 29.

American Hoist & Derrick Co.—Booth N-15. Newly redesigned "American" gasoline hoist, No. 28.60 G; genuine "Crosby" clips; and enlarged photographs of the new "American" gasoline shovel, crane, and dragline combination, and of the "American" steel stiffleg derrick; of other pieces of material handling equipment used by highway builders. Joe Cox of St. Paul office and representative fo Chicago office in charge.

American Malleable Castings Assn.—Booth W-12.

American Manganese Steel Co.—Booth E B-17 and 18.

American Steam Pump Co.—Booth W B-1 Barton portable pumper for contractors and fire service. Ben. D. Barton and G. H. Griggs in attendance.

American Steel & Wire Co.—Booth S B-4 and 5. Road and highway concrete reinforcement fabrics—both electric weld and triangle mesh. American wire rope highway guard table. Road sign posts. B. S. Pease, P. T. Coons, O. T. Allen, J. G. Schodtler in attendance.

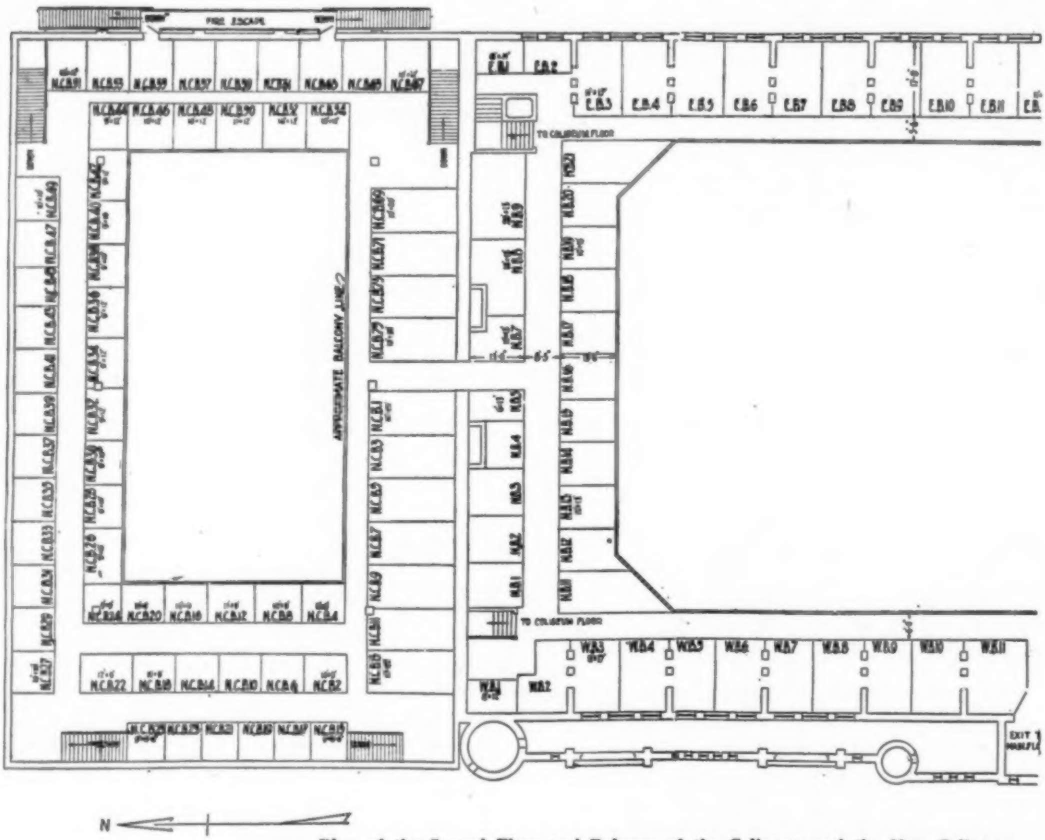
American Tar Products Co.—Booth B R-16, 17, 26 and 27.

American Vibrolithic Corp.—B R-35, 36, 46 and 47. Vibrator, platforms used in connection with "Vibrolithic" and "Interlocking" pavements, pictures, including motion pictures of the operation, pamphlets, test data, samples of pavement, etc. L. R. Mac Kinzie, Col. N. D. Dean, A. R. Hirst, H. D. Tillson, O. C. Hubbard, and H. J. Kuelling in attendance.

Amiesite Asphalt Co. of America.—N B-15, 16 and 17. Samples of Amiesite pavements; a minature railroad crossing, showing the construction of same, designed with Amiesite; a demonstration of crack patch material for concrete roads and also a demonstration of asphalt filler for filling new fractures in concrete roads; together with hundreds of photographs of the Amiesite roads from Quebec to Texas, showing Amiesite in all climates. H. M. Stafford and Donald M. Hepburn in charge.

Anthony Co.—Booth N C-31. Mounted Anthony dump bodies, photographs, literature, etc. W. C. Anthony, R. R. Howard, E. L. Flanigan, W. V. Tomlinson, R. G. Linsner, A. L. Smith in attendance.

Armco Culvert & Flume Manufactorers' Assn.—W B-14 and 15. Standard sections of corrugated iron culverts for highway use, from 12 to 60 in. diameter. Section



Plan of the Second Floor and Balcony of the Coliseum and the New Coliseum

of corrugated iron culvert which has served under a California highway for 17 years and was recently removed for exhibition purposes. Large wall chart showing results of recent tests on rigid and flexible types of culverts. Manufacture of 8-gauge metal for large diameter culverts. Anton S. Rosing in charge.

The Asphalt Association.—Booth B R-15 and 25. Sawed sections of asphalt pavements, publications, photographs, charts showing the development of the asphalt industry and in asphalt pavements laid in recent years. J. E. Pennybacker, Prevost Hubbard, W. E. Rosengarten, C. S. Lee, L. D. Smoot, W. C. Ricketts, Bruce Aldrich, G. W. Craig, V. L. Ostrander, H. C. Smith in attendance.

Asphalt Block Pavement Co.—Booth B R-44. Samples of various sizes of asphalt blocks, samples of materials used in the manufacture of asphalt blocks; photos of street, etc. Fletcher Rogers, Everett J. Snyder, Frank W. Klett in attendance.

Associated Equipment Distributors.—N C B-13. Illustrations of the various lines of equipment handled by distributors throughout the country.

Associated Pennsylvania Constructors.—Booth B R-1, 2, 3 and 4.

Atlas Lumnite Cement Co.—N C B-28 and 30. Pictures, literature, etc., regarding construction projects carried out with this material. H. G. Bille in charge.

Austin Machinery Corporation.—Booth C-20. Excavating machinery. G. T. Stuart, O. A. Seyferth, G. S. Pierson, L. B. Birckhead, M. J. Holian, A. L. Richardson, L. F. Washburn, C. L. Crook, H. Lamont, H. A. Barber, M. Farrar and E. H. Bostetter in attendance.

Austin Manufacturing Co.—Booth 35. Austin motor sweeper.

Austin-Western Road Machinery Co.—Booth 37. Pup roller powered with a 10-20 McCormick-Deering tractor, leaning wheel Rip-Snorter senior grader. Motor grader with Fordson power plant. Another Motor Grader with the 16-30 McCormick-Deering power plant. Austin 4-cylinder, 10-ton motor roller with pneumatic scarifier attachment. Aurora Grader with new style blade control mechanism. A Western No. 1 Patrol Grader, also with improved blade control mechanism. H. F. Barrows and W. C. Cornwell in charge.

Autocar Sales & Service Co.—A 2.

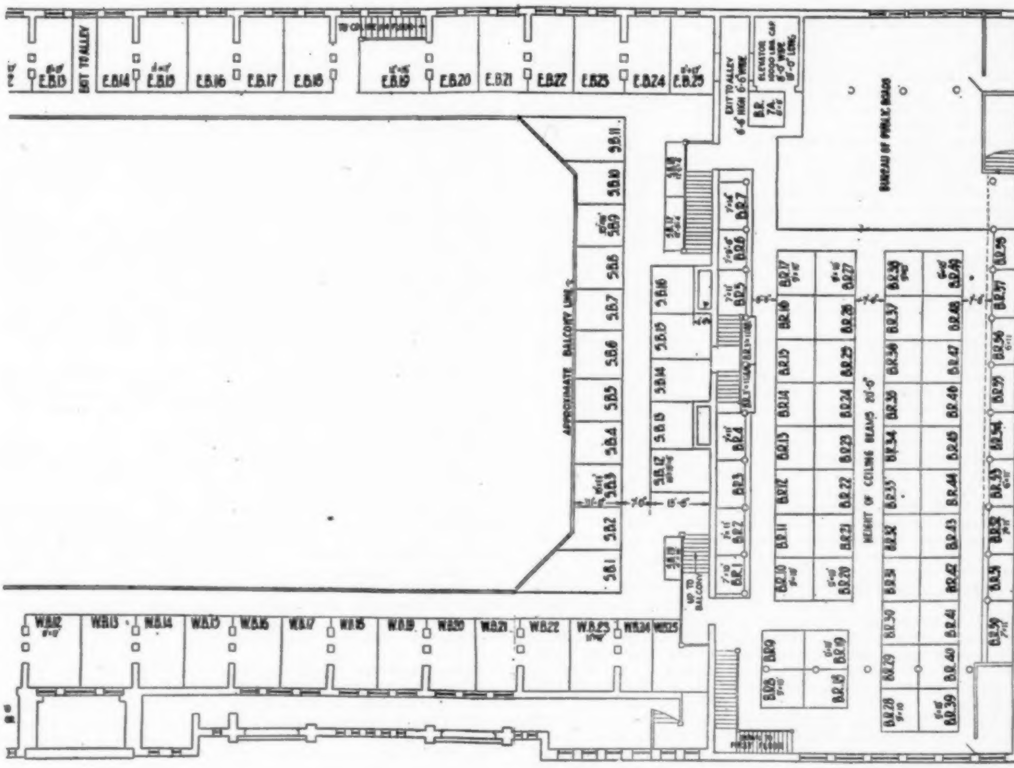
Automatic Signal & Sign Co.—Booth E B 24.

The Baker Mfg. Co.—Booth N C-6. Earth moving equipment including Baker Maney self loading scrapers, auto truck snow plows, one-man rotary tractor scrapers. E. E. Staley, J. G. Miller, L. A. Ginzel, W. C. Staley, E. E. Buck, W. H. Davis in attendance.

The Barber Asphalt Co.—Booth W B-24 and 25. Distribution of literature on street and road building materials, paving machinery, etc., also a miniature model of an Iroquois steam jacketed pump. J. E. Morris, G. R. March, R. G. McKay and W. F. Hartzoll in attendance

Barber-Greene Co.—Booth 12. Material handling and batching equipment, ditchers; shown by working models, movies, and the machines themselves. H. A. Barber, W. B. Greene, H. S. Greene, J. E. Maison, J. M. Burns, C. B. Gould, J. P. Fogarty, W. T. MacDonald, E. D. Cassel, R. L. Wood, W. H. C. Mussen, S. A. Gilliard, F. S. Sawyer, J. A. Gurney, W. B. McCardey, H. R. Leonard, K. C. Eller, D. B. Frisbie, S. D. Brown, E. F. Lamprey, Frank Ness, etc. in attendance.

Barnes Manufacturing Co.—Booth N-10. Model No. 30 road builders pumping plant, Model No. 1000 portable air compressor unit 118 ft. displacement, Model L-308—a duplex plunger trench pump, Model L-306 single plunger trench pump, Model H-302-S single Anti-Splash power diaphragm pump, Model No. 700 direct connected



Balcony and the Ball Room, Showing Locations of Booths of Exhibitors at the Road Show.

centrifugal pumping unit. J. C. Gorman, A. C. Saxe and G. H. Riste in attendance.

Barrett Co.—Booth S-1, 2 and 3.

Bates Machine & Tractor Co.—Booth W-8.

Bay City Dredge Works.—Booth N C B-57. Literature and enlarged photographs and views of Model 16 B convertible excavator at work. A complete machine will be exhibited in action just south of the Coliseum on Wabash avenue and 16th street Morgan Ramsay, W. S. Ramsay, J. N. Kerr, C. G. Wagner in attendance.

Beaver Mfg. Co.—Booth N-13. One 4¾ x 6 four cylinder engine Model JE one 4¾ x 6 six cylinder engine Model JD, one new Model RX 6½ x 7 four cylinder engine. A. D. Chandler, P. C. Neacy and E. C. Trede in attendance.

Belle City Mfg. Co.—Booth G-10. Model B and Model C trackpull for Fordson tractors. C. L. Russell, W. R. Tretter, R. O. Hendrickson and Geo. Nelson in attendance.

Black & Decker Mfg. Co.—Booth R B-45.

Blaw-Knox Co.—Booth 6, N C B-18 and 22. Seventy-two ton batcherplant equipped for inundation; duplex charging bin; adjustable measuring batches; road forms, street and sidewalk forms; clamshell bucket; also working models of clamshells, demountable bins, circular steel bin, duplex charging bin and truck turntables.

Bradley-Badger Engineering Co.—Booth N C B-71.

Brown Hoisting Machinery Co.—Booth 19. 1926 model ½-yd. gas shovel crane.

Brown-Lipe Gear Co.—Booth N C B-63. Cutaway model of Model 60 7-speed main frame transmission clutch and control; also cutaway model of Model 31 3-speed unit power transmission, clutch and control. Henry A. Pierce, P. C. Burt, A. E. Parsons in attendance.

Buda Co.—Booth N-9.

Buffalo-Springfield Roller Co.—Booth N C B-32 and 34. Photographs and printed matter.

The Buhl Co.—Booth N C-8. Portable and stationary air compressors; machines shown 90-C, 115-Y, 100-FD, 55-C, 90-DP. R. J. Dick, W. Q. Buhl, W. W. Kline in attendance.

Burch Plow Works.—Booth E B-11 and 12.

Butler Bin Co.—Booth N G-16. Batch proportioning hopper by volume; Batch proportioning hopper by weight; model of steel storage bin. Morgan R. Butler, Carl E. Riblet, M. E. Kelley in attendance.

Byers Machine Co.—Booth 15.

Bryne Brothers.—Booth N C B-23 and 25.

The Philip Carey Co.—Booth S B-8. Elastile expansion joint and elastic rail filler. C. V. R. Fullenwider, E. H. Berry in attendance.

Carr Fastener Co.—Booth N B C-2. Dot high pressure lubricating system for road making machinery, trucks and passenger cars. P. K. Niven, A. W. Smith, A. H. Taylor, R. C. Smith in attendance.

Case Threshing Machine Co.—Booth G-14.

Caterpillar Tractor Co.—Booth 1. Caterpillar tractors, 10 ton, 5 ton, 2 ton, models 60 and Model 30. M. M. Baker, O. L. Starr, E. I. Jones, M. A. Champlain, S. H. Ralston, W. Crawford and Fred Lewis in attendance.

Celite Products Co.—Booth W B-23.

C. H. & E. Manufacturing Co., Inc.—Booth E-8. New No. 11 triplex pump.

Chain Belt Co.—Booth 18, N C B-12. Rex 14-S concrete mixer, one 27-E paver, and one 3½ ft. tilting type mixer. Walter Prellwitz in charge.

Chausse Oil Burner Co.—Booth N C B-69. Asphalt street repairing machinery-oil burning fire wagon, surface heater, smoothing irons, kerosene torches (portable asphalt plant. W. McK White, W. G. Chausse, J. R. Bakstad in attendance.

Chicago Automatic Conveyor Co.—Booth W D-9. Conveyors. M. L. Turney in attendance.

Chicago Pneumatic Tool Co.—Booth A-6. Portable air compressors, gasoline engine driven, 100 to 300 cu. ft. capacity; single stage air compressors, synchronous motor driven 100 cu. ft. capacity in operation; C.P. rock drills; concrete breakers; pneumatic clay diggers; pneumatic brick fill tampers; pneumatic tools. N. B. Gatch, G. C. Vanden Boom, O. C. Estergreen, L. S. Hoffman, A. L. Burgy, D. W. Brill, J. W. Cole, H. C. Gilligan, H. W. Buker, R. F. Eissler, W C Straub, T. G. Smallwood, H. Clark, in attendance.

Chilton Class Journal Co.—Booth S B-17. Magazine.

Clark Tructractor Co.—Book A-5. Automatic end dump tructractor; flat auto dump tructractor; both of 2-ton capacity. Walter Nochumson, J. W. Taylor, R. J. Burrows, M. L. Hanlin, in attendance.

Clay Products Association—B R-12 and 22. Vitrified clay sewer pipe and vitrified clay culvert pipe. T. R. Brown and W. D. Gerber in charge.

The Cleveland Pneumatic Tool Co.—Booth N C B-5. Truss air springs for trucks, busses for reducing impact on roads. H. A. Lantz, D. R. Taylor, F. H. Burr in attendance.

Cleveland Tractor Co.—Booth N C-4. New industrial crawler tractor, The Cleetrac Model "K," 15-25 h.p. In addition to showing the tractor and a cut-out motor, numerous separate units of design will be displayed. The latter will include a complete transmission assembly with power take-off attachment, a side frame, together with a lower track wheel and shaft disassembled so as to point out the plain bearings with which the wheels are equipped. C. D. Fleming, E. R. Galvin, G. D. Groce and H. E. Orr in attendance.

Cleveland Wheelbarrow & Mfg. Co.—Booth N B-8.

Climax Engineering Co.—Booth W-11.

Clyde Iron Works Sales Co.—E-5 and 6. Three improved gas hoists, two of which are double drawn designs for particular needs of contractors; the third a 50 h.p. unit (3 drum with single den for clam shell bucket operation.) C. A. Lustru, J. R. McDiffeat, J. T. Frost and all branch office managers in attendance.

Commerce Motor Truck Co.—Booth N C-1. Commerce relay drive truck chassis; electric model showing relay drive principle. R. A. Shelly, E. B. Dixon, L. L. Whaley, L. J. Stevenson, W. L. Vreeland, H. F. Irvine in attendance.

Concrete Steel Co.—Booth B R-8 and 18.

Concrete Surfacing Machinery Co.—Booth N C B-61. Machines for removing fins, board and form marks and all surface irregularities on buildings, bridges and all concrete construction. Mentor Wetstein and Sam Dreifus in attendance.

Conneaut Shovel Co.—E B-23. Shovels, spades and scoops. Robert Van Gorder in charge.

Construction Machinery Co.—Booth N C-19.

Continental Motors Corp.—Booth S-4.

Contractors' & Engineers Monthly—Booth N C B-20.

B. M. Cropp Co.—Booth A-11.

Cummer & Son Co.—Booth B R-7A.

Curtis Pneumatic Machinery Co.—Booth E-20. Curtis portable compressor for the Fordson, shown as combined unit with Fordson complete. Edwin S. Harrison, R. P. Stone in attendance.

Cyclone Fence Co.—Booth N C B-31, 33, 35. Cyclone "Road Guard." J. H. Kinney in charge.

Domestic Engine & Pump Co.—Booth E-16 and 17. Road builders' portable triplex pump unit, portable 90 degree angle drive unit air compressor, D-4 trench pump, double drum heavy duty hoisting unit, centrifugal pump unit. W. E. Barbour, C. B. Segner, P. M. Kidd, Walter Howland, in attendance.

The Dow Chemical Co.—Booths S B-14 and 15. Dowflake Calcium Chloride for concrete acceleration, curing and dust layer work. Miniature road will be on exhibition showing the difference between Dowflake and other roads. Also miniature pumping plant showing first process in steps of manufacture of Dowflake. Edgar Collat, Don Williams, Tom Williams, Wm. Rogers, J. E. Murphy, Geo. Metcalf, F. A. Koch, H. T. Knowles, John Lewin, W. M. MacGillivery, Mr. Kearney, and Mr. Putnam in attendance.

Dravo Contracting Co.—Booth N C B-4 and 8.

Duff Mfg. Co.—Booth W B-3.

Eagle Iron Works—Booth E B-4.

Eagle Wagon Works—Booth N B-19 and 20. 1 Eagle dump wagon equipped with a grader attachment and 3-horse hitch. Eagle 1-yd. gravity dump body with contractors' seat. Eagle under-body hoist, with top box making 2-yd. capacity. C. C. Avery and Earl R. Graham in charge.

Eisemann Magneto Corp.—Booth N B-9.

Electric Wheel Co.—Booth N-11. Rubber-tired disc wheels for the Fordson and trailers especially adapted for use with that tractor; also crawler tread for the Fordson. F. F. Alexander, A. M. Calkins, M. M. Miller, V. M. Drew in attendance.

Elgin Sales Corporation—Booth 33. 1926 Model Elgin street sweeper. A. M. Anderson in charge.

Engineering & Contracting Publishing Co.—Booth B R-9 and 19. Magazine.

Engineering News Record—Booth S B-12. Magazine.

Equipment Corporation of America—Booth A-18 and 19. Gasoline hoist, portable track, air compressor, clamshell bucket, derrick. H. M. Capron. Jos. V. Sullivan, T. G. Davis, W. J. Conley, P. S. Smith and Richa. Evans in attendance.

Erie Steam Shovel Co.—Booth 11.

Erie Steel Construction Co.—Booth N C-14. 20-ton capacity steel bin with weighing aggremeter; one set volume aggremeter boxes one 1-yd. Erie clamshell bucket. E. F. Jones, J. A. Auld and T. R. Buss in attendance.

Essco Mfg. Co.—Booth B R-30, 31, 32, 41, 42, 43. Stop and Go Signals; special controllers; through street stop signs; fine stop signals; electrical directional signals. C. A. Ward, L. W. McOmber, H. D. Oakland, J. R. Walters in attendance.

E. D Etnyre & Co.—Booth G-1. Model F heating and distributing unit mounted on motor truck chassis. E. D. Etnyre, G. M. Etnyre, H. H. Etnyre in attendance.

Farasey Mfg. Co.—Booth B R-51.

Farrell-Cheek Steel Foundry Co.—Booth E B-5. "Farrell's-85" super cast steel—castings for a large number of purposes. F. Frith Pickslay, M. L. Ritter, E. R. Dougherty in attendance.

The Fate-Root-Heath Co.—Booth 26. 8-ton Plymouth gasoline locomotive; 12-ton Plymouth gasoline locomotive. H. R. Sykes, R. N. Lowry, Roy M. Nelson, J. A. Root, C. E. Heath, F. B Carter in attendance

S Flory Manufacturing Co.—Booth W B-8. New 10 h.p. double drum gasoline engine driven hoist, equipped with Continental 4-cylinder motor; also special exhibit piece consisting of a drum with gear and friction thrust mechanism showing construction of Flory friction nut and positive releasing device. Theo. Hanan in charge.

Foote Concrete Machinery Co.—Booth 3.

Foos Gas Engine Co.—Booth B R-1A.

A. W. French & Co.—Booth G-12, N C-5. Ord concrete road finishing machine; also entirely new machine for cutting the finish earth grade. Messrs. French, Allen, Cox, Kiest, and Ord in attendance.

French & Hecht—Booths W B-16 and 17. Wheels for industrial tractor service, motor trucks, trailers, etc.; also various types of steel wheels for road work. J. H. Plochn and E. E. Einfeldt in charge.

Fruehauf Trailer Co.—Booth 4G.

Full-Crawler Co.—Booth N C-25. One standard trackson full-crawler, one special trackson full-crawler both mounted on Fordson tractors, and one standard trackson mounted on Fordson tractor with a Sargent snow plow. C. W. O'Connor, I. W. Kunert in attendance.

Fuller & Johnson Mfg. Co.—Booth E-2. Power units, including electric light units. C. L. McMullen and A. H. Holte in attendance.

Galion Iron Works & Mfg. Co.—Booth G-11 and 13.

Garford Motor Truck Co.—Booth A-4. Model 30, 1½ ton truck chassis; Model 50, 2½ ton with road builders dump body and hoist installed. R. Scott Smith, J. W. Van Horn, H. W. Fenton, C. C. Gwynne in attendance.

General Motors Truck Co.—Booth 29. A special one batch road builders' job will be shown; also, a two batch job. Illuminated photographs of trucks in service will also be shown. H. W. Howard in charge.

Gilbert Mfg. Co.—Booths G-16 and 18.

W. S. Goodwin Co.—Booth S B-16. Steel paving guards for protecting the edges of all types of paving. Street railway paving, railroad crossings, curbs and steps. W. S. Goodwin, A. L. Jackson in attendance.

Good Roads—Booths B R-4A and 4B. Magazine.

The Good Roads Machinery Co.—Booth N C-27. Road building machinery. Good Roads, Jr., road roller. Good Roads motor grader, Good Roads snow plow attached to GMC truck. C. Stockmann, Jr., C. J. McNeill, E. S. Philips, George C. Abbe in attendance.

Grasselli Chemical Co.—Booth B R-34.

Hadfield Penfield Steel Co.—Booth 4, B R-28.

Jas. A. Hagy Wagon Co., Inc.—Booth E B-22. A new dump wagon; wagon first exhibited. Mr. Bradley in charge.

Haiss Mfg. Co. Inc., George—Booth 22. Haiss creeper loader, new Haiss precision batch hopper, a Haiss portable belt conveyor, Haiss traxion chassis for Fordson tractor and moving picture display. A. W. Haiss in charge.

Harnischfeger Sales Corp.—Booth 23. Diesel shovel (1 yd.) truck crane, ½-yd. gas shovel, trench hoe trenching machine and backfiller. R. A. S. Johnson in charge.
Hastings Pavement Co.—B R-33. Asphalt paving and flooring blocks. T. J. McNally and P. L. Thompson in charge.
The Hayward Co.—Booths N C B-65 and 67. ½ cu. yd. class "G" clam shell bucket; ½ cu. yd. class "E" clam shell bucket; 2 cu. ft. class "E" clam shell bucket; 2 cu. ft. multi power orange peel bucket; 12 in. dwarf orange peel bucket; model drag scraper bucket. H. S. Atkinson, H. M. Davison, E. R. Dwelle in attendance.
The Heil Co.—Booth G-17. Hydro dumping units operated by electric motors; also different types of gravity bodies, sprinkler tanks, hand hoists. J. P. Heil, J. F. Heil, E. O. Habhegger, Jos. Wais, E. C. Gilmore, H. A. Winton, Chas. Eisenberg in attendance.
Heltzel Steel Form & Iron Co.—Booth N C-24. Heltzel steel road forms; Heltzel steel curb and gutter forms; Heltzel steel sidewalk forms; Heltzel bins; Heltzel batchers and line of road equipment.
Henion & Hubbell—Booth B R-52.
The Hercules Corporation—Booth E-18. Small single cylinder, horizontal engines for operation of industrial machinery. Geo. K. Specht, R. L. Mazier in attendance.
Hercules Motors Corporation—Booth N-12. Model "OX" 4 in. x 5 in. complete power unit; a Model "G" 4¾ x 5¾ in. engine; a Model "TX" 5½ in. x 7 in. engine; also an assortment of parts for each model on exhibition. Chas. Balough, E. R. Jackson, D. W. Latta, John Kraus, R. E. MacKenzie in attendance.
The Highland Body Mfg. Co.—Booth N B-21. Highland Model D cabs for motor trucks. Samuel Froome, Chas. J. Stoll, William Morrison in attendance.
Highway Engineer & Contractor—Booth N B-7. Magazine.
Highway Signal Co.—Booth E B-7.
Highway Trailer Co.—Booth N C-13. Eight-wheel contractor's trailer four-wheel drop-frame garbage and ash trailer. Four-wheel commercial trailer. J. W. Manhall E. L. Moorman, H. M. Raymond in attendance.
Hinkley Motors Inc.—Booth E-1.
Hotchkiss Steel Products Co.—Booth N C B-9 and 11. Steel forms.
Huber Manufacturing Co.—Booth G-15. 4-cylinder motor roller.
The Hug Co.—Booth A-12. Road builders trucks; turntable; subgrading machine. R. K. Tibbetts, Ray Bliss, V. Koch, F. O. Smithson in attendance.
Hughes—Keenan Co.—Booths N C-10. and W B-20 and 21. Motor trucks with 2 and 3-yd. and 1½ yd. dump bodies; also various kinds of hand hoists and new steel buck seat. C. W. Walker, J. D. Corrigan, Eugene Evans and Howard Gorsuch in charge.
The Humphreys Mfg. Co.—Booth W B-2. Humphreys lift and force trench pumps, both single and double units; also Humphreys high capacity diaphragm pumps and a new hand diaphragm trench pump. Paul Johnson, S. H. Orr, P. H. Schultz in attendance.
Chas. Hvass & Co. Inc.—Booth 10. "Hvass" heavy bituminous distributor. Chas. T. Hvass in charge.
Hydraulic Hoist Mfg. Co.—Booth E-7. Hydraulic hoists (St. Paul), both vertical and underbody types; three sizes vertical; three sizes underbody; also electrically driven model underbody hoist; 1 electrically driven full size underbody hoist. V. L. Farnsworth, B. P. Lattner, J. H. Bell, H. J. Raich in attendance.
Ideal Concrete Machinery Co.—Booth W B-17. H. F. Loucks, Paul Brubaker and J. W. Freiberg in attendance.
Indiana Truck Corporation—Booth 31. Model 15-A Road Builder's Special 2-yd. body Hydraulic underbody hoist, equipped with road scraper; also big Steve Indiana Model 41 4-5 ton chassis with major units quickly demountable. H. K. York, H. E. Blasingham, C. B. Summerland, Fred J. Fowler, J. W. Stephenson in attendance.
Industrial Works—Booth N C B-3.
Ingersoll-Rand Co.—Booth 24. Machinery on floor. portable compressor, stationary compressor, sinking pump, drill steel sharpener, pneumatic tools and rock drills. Demonstrations sharpening drill steel, shanking drill steel, riveting, rock drilling and trench work. H. K. Rollins in charge.
Inland Engineering Co.—Booth EB-20. Oro special steel castings for all makes of trench machines and backfillers. Special features will be improved extension side cutters; Hyatt roller bearing fairleads for backfillers; improved all steel slats for caterpillar blocks. Drill press will be installed to demonstrate the manner in which certain kinds of Oro steel resist drilling. W. S. McKee, E. S. Black, E. C. Bauer, Kenneth Jensen, A. H. Exton and E. A. Lerner in attendance.
Insley Mfg. Co.—Booth N C-15. Insley excavator. C. S. Wagner, A. C. Rasmussen, R. B. Dorward, Henry Jameson in attendance.
International Harvester Company of America—Booth N C-17. Motor trucks with dump bodies; industrial tractors for road work. W. F. McAfee, P. Y. Timmons, H. K. Curll in attendance.
International Motor Co.—Booth 4, 3.
Jennison-Wright Co.—Booth N C B-19.
C. S. Johnson Co.—Booth E-19. Johnson batch measuring hoppers; Johnson batch weighing hoppers; Johnson weighing device; Johnson demountable bins. C. S. Johnson, W. J. Brennen in attendance.
Jones Superior Machine Co.—Booth N C B-42. Contractors' saw rigs. F. G. Walker, H. D. Cameron in attendance.
Kalman Steel Co.—Booth E B-10.
Kentucky Rock Asphalt Co.—Booths B R-13, 14, 23 and 24.
Keystone Driller Co.—Booth G-6. Model 4-26 Keystone traction excavator with gas drive and front crawler mounting, operated at the exhibit by electric motor. C. W. Holmes, J. Vale Downie, Rex Downie, F. B. Ransom, C. D. Hanshew, A. F. Kroen, F. Oliver, P. Culbertson, H. H. Elmire in attendance.
Kinney Mfg. Co.—Booth 34.
Klauer Mfg. Co.—Booth N B-18. Metal culvert pipe, metal head and side walls. H. B. Kenny, R. J. Schuppener, J. B. W. Lomberg in attendance.
Knickerbocker Co.—Booth G-7. 7-S concrete mixer, equipped with power loader and automatic water tank, and No. 5 combination swing cut-off and ripping portable saw rig. W. W. DuPre in charge.
Koehring Co.—Booth 16. 27E paver and No. 1 shovel. Home office staff and entire sales organization in attendance.
Koppel Industrial Car Equipment Co.—Booth W B-12. Photographs of batch boxes, batch box trucks, portable track, switches, etc. H. W. Redman, O. E. Kantenwein in charge.
Kwik Mix Co.—Booths N B-51 and 53. Concrete mixers. One 3½ side loader; one 3½ trailer and one plaster and mortar mixer. John P. Gilson, Michael Gilson, M. J. Greiveldinger in attendance.
Lakewood Engineering Co.—Booths C-2 and W-13. 1926 model finishing machine combining two machines in one, a screed and a tamper; also standard screed, and steel subgrader, graderooter, narrow gauge track, cars, batch boxes, 7-S mixer, and Carr road forms. Lion Gardner in charge.
La Plant-Choate Mfg. Co.—Booth N C-26. Snow plows, bull dozers, hydraulic self-loading scrapers. E. W. LaPlant, R. E. Choate, J. Ross, W. L. Franks, M. L. Mundy in attendance.
Leach Co.—Booth 21.
Lee Trailer & Body Co.—Booths S B-9 and W B-13. Steel gravity dump bodies. J. B. Bull in charge.
Le Roi Co.—Booths E-3 and E-4. Complete line of heavy duty engines and power-units that are used on road building machinery, such as concrete mixers, pavers, road pumps and road finishing machinery. W. R. Karll in charge.
A. Leschen & Sons Rope Co.—Booth N C B-16. Samples of wire rope for all road building and material handling equipment. M. R. Arnold, V. C. Browne, E. J. Schillinger, C. K. Traber in attendance.
Link-Belt Co—Booth 5. Full size Link-Belt crawler equipped with new dipper shovel stick, and a full size crawler type loader, working models of the Peck carrier for handling coal and ashes, cement, stone and other materials; a complete sand and gravel working model will also be shown. Models of silent chain together with many other types of chain manufactured by Link-Belt Company; the new anti-friction belt conveyor idlers; sprocket wheels; buckets; screw conveyors; various power transmission devices; and a motion picture of the Link-Belt Crawler Crane in operation in Florida and other parts of the country. G. H. Olson, C. S. Huntington, A. Eilesgaard, N. A. Weston, S. L. Haines, R. Y. MacIntyre in charge.
Lintz & Son, H.—Booth W B-5.
Littleford Bros.—Booths E-9 and 10. Asphalt heating equipment consisting of maintenance and construction outfits; also new type of rotary sand heater; also an asphalt melting kettle designed exclusively for burning oil as fuel. Such attachments as barrel hoist and hand spraying outfit will also be shown. The Andresen road repair outfit will be one of the principal exhibits. Herman H. Strietmann and L. W. Glaser in charge.

Little Red Wagon Mfg. Co.—Booth 7-A. Little red dump wagon; Little red dump wagon trailer for Fordson; Stroud elevating grader. A. C. Thomas in charge.

Lufkin Rule Co.—Booth 39. Complete line of measuring tapes, rules, etc., as used by engineers, surveyors, contractors and road builders. S. A. McConnell and R. M. Benjamin in attendance.

The MacLeod Co.—Booth N C B-59. Surface heater; concrete heater; sprayer outfit; tar kettle; a number of pictures. James Lauder in attendance.

Macwhyte Co.—Booth E B-13. Model of good road, showing wire rope guard rail; also cases showing samples of wire rope. James A. Boope, Jessel S. Whyte, Geo. W. Drysdale and Ray A. Reading in attendance.

Manufacturers Record—Booth S B-10. Magazine.

The Marion Steel Body Co.—Booths N C B-39 and 41. Steel dumping bodies. E. H. Fishmer in attendance.

Marsh-Capron Co.—Booth N C-28. 7-S concrete mixer with power loader measuring water tank; builder's hoist and feed water pump; mounter on four wheel trailer; also batch mortar mixer on 2-wheel trailer. R. C. Weller, A. D. Mosby in charge.

Master Truck, Inc.—Booth A-15.

McKiernan-Terry Co.—Booths N C B-52 and 54. Operating model of 9B pile hammer, which will drive timber piles in a tank below water level. Another smaller model of N-6 hammer will drive miniature sections of steel sheet piling and will then be inverted and extract the same. Will also have a Doughboy jack and a core drill for road testing work. L. H. Buttenheim, E. R. Evans and E. J. Troy in charge.

McMyler Interstate Co.—Booth N C-22. Convertible gas shovel and two types of excavating and rehandling buckets. F. J. Wanderer, P. B. Ellison, H. E. Green, J. E. McFate, H. L. Musser, R. B. Crenshaw, E. K. Hayes, M. G. Hennessey, Mr. Forrestal, W. S. Doxsey, C. H. Sauerston, M. E. Culhan, R. S. Rimanoczy, Mr. Wright, R. L. Mead, W. A. Goodfriend, C. L. Currie in attendance.

Mead-Morrison Mfg. Co.—Booth A-15. Mead-Morrison "55" tractor. P. T. Redfern, F. O. Clukies, C. E. Robinson in attendance.

Metal Forms Corp.—Booths E-11 and 12. Road rail, curb and gutter forms, sidewalk forms, manhole, etc. G. H. Miller and R. M. Moss in attendance.

Metalweld Service Corporation—Booth N C B-7. Air compressors, air tools. C. F. Oechsle and O. S. Compton in attendance.

Metropolitan Body Co.—Booth E B-3.

Miami Trailer-Scraper Co.—Booth G-8. Miami 1-man power scraper. I. T. Goodrich and C. R. Dobbins in attendance.

Milburn Co., Alexander—Booth W B-11. Milburn carbide lights, welding and cutting apparatus, oil burning equipment and acetylene welding generators, together with accessories and supplies. A. F. Jenkins, C. R. Pollard and F. G. Squire in charge.

Milwaukee Locomotive Co.—Booth W-1. Milwaukee type H-7, 7 ton, four speed gasoline locomotive. Geo. H. Fannin in charge.

Mohawk Motors Corp.—Booth E B-25.

Monarch Tractors Inc.—Booth 17. First showing of new 10 ton Monarch tractor. H. B. Baker, R. W. Gotshall, A. B. Webb and T. E. Racek in attendance.

Mosher Mfg. Co.—Booth S B-13.

The Mundie Mfg. Co.—Booth E B-6. Portable air compressors. S. E. Noles, Geo. W. Mundie in attendance.

National Highways Association—Booth S B-20.

National Paving Brick Mfrs. Assn.—Booths B R-10, 11, 20, 21. E. E. Duff, Jr., S. A. Knisely in attendance.

National Steel Fabric Co.—Booths S B-2 and 3. National steel fabric in various styles (consisting of different spacings of wire and different gauges of wire) for use in concrete roads and pavements. C. B. Dugan in charge.

Northern Conveyor & Mfg. Co.—Booth N C B-36. Four pieces of model equipment, combining into a complete loading, screening and storage plant for sand, gravel and materials of that kind. J. B. Whitnall and H. E. Whitnall in charge.

Northwest Engineering Co.—Booth 14.

Novo Engine Co.—Booth 28. Novo gasoline engines, (one, two and four cylinder, 1¼ to 40 h.p.); single and double drum hoists; diaphragm, centrifugal and pressure pumps and drag line hoists. Company executives and district managers in attendance.

O'Connell Motor Truck Co.—Booth A-13. Two way drive super truck. Wm. L. O'Connell, Mark J. Sheehan, George Repkow, James Bundo in attendance.

Ohmer Fare Register Co.—Booth E B-1.

Oil Jack Co. Inc.—Booths N C B-24-26. Oil jacks. Otto Bieber in attendance.

O. K. Clutch & Machinery Co.—Booth E-13. Air compressors, gasoline hoists. A. M. Lupton and H. Dinchel in attendance.

Olsen Testing Machine Co.—Booth B R-40.

Orton & Steinbrenner Co.—Booth N C-20. 1 Model "T" crane with 40-ft. boom and ¾-yd. clamshell; 1 Model "V" ½-yd. shovel. Messrs. Mertz, Whitney, Robertson and Orton, Jr., in attendance.

The Osgood Co.—Booth 13. 1-yd. Osgood heavy duty gas shovel. E. C. Smith in charge.

Owen Bucket Co.—Booth 25.

Page Steel & Wire Co.—Booths N B-11, 12 and 13. Model installations of Page Hi-Way Guard; several display boards showing pictures of Hi-Way Guard installations in every state in the union; also pictures of typical accidents which could have been prevented by the use of woven wire Hi-Way Guard. Motion pictures showing how Page Hi-Way Guard stands up when actually hit by an automobile, will be shown.

The Parsons Co.—Booth N C-30. New Model 21 public service ditcher. Mr. McCardell, Mr. Keiser, Mr. McElroy, Mr. DeWind, Mr. Vaughn, Mr. Clark, and Mr. Kircher in attendance.

Perforated Roller Works—Booth N C B-50. 5 sizes of perforated roller. One exhibit of ball and socket contraction joint; one exhibit of ball and socket transverse; expansion joint; one exhibit of perforated concrete finishing belt. F. L. Shidler, R. D. Gregg in attendance.

Perry Co.—Booth E B-2.

Peru Plow & Wheel Co.—Booth N C B-46. Metal wheels. Ferd. Luthy, Jr., T. P. Luby in attendance.

Pit & Quarry—Booth B R-54. Magazine.

Pittsburgh Testing Laboratory—Booths B R-55-56. Bulletins and other descriptive publications; views of various highways, buildings, etc. H. H. Craver, J. M. Moss in attendance.

Portland Cement Association—Booths B R-37, 38, 48, 49. Photographs of concrete pavements; concrete road markers in the new U. S.; standard designs; reception space. C. R. Ege, Sydney L. Smith, W. F. Tempest, W. E. Barker, E. K. Smith in attendance.

Public Works—Booth S B-19. Magazine.

Racine Radiator Co.—Booth E B-9. Radiators for cooling internal combustion engines for power units, air compressors, cranes, drag lines, shovels, excavators, backfillers, trenchers, graders, mixers, hoists, drillers, locomotive tractors, trucks, busses and every other heavy duty service. D. T. MacLeod, F. M. Young, Roger Birdsell, J. J. Hilt, A. C. Owen in attendance.

Rawls Machine & Manufacturing Works.—Booth E-10A.

Ransome Concrete Machinery Co.—Booth 7.

Remmell Mfg. Co.—Booth N C B-17 and 19. Concrete mixers. L. P. Rosenheimer, H. W. Keyes in attendance.

Republic Iron Works—Booth W B-17. Concrete mixers. E. E. Berry in attendance.

Republic Motor Truck Co.—Booth A-16. 1½ ton Republic truck equipped with a 1½-yd. gravity dump body, and one 3-ton Republic truck equipped with a 2-yd. dump body with underbody hoist, and also equipped with a Michigan anti-chatter dump machine. O. W. Hayes, J. C. Haggart, Jr., R. E. DeVogt, W. P. Hanson, H. C. Riggle, Geo. Ogden in attendance

Riehle Bros. Testing Machine Co.—Booth E B-8. New style 20,000 lb. compression machine for testing cement cylinders 2 in. diameter by 4 in. long; standard 1,000 lb. automatic cement testing machine for testing cement briquettes; new style bronze molds of two kinds; rolled steel molds for the 6 in. by 12 in. and 8 in. by 16 in. concrete cylinders, and also an entirely new patented compressometer, especially arranged for indicating the compression of 2 in. by 4 in. cylinders. Joseph S. Steen and Francis Buckingham, in charge.

Robt. Bosch Magneto Co., Inc.—Booth W B-6.

Rock Products—Booth B R-57. Magazine.

Rotary Snow Plow Co.—Booth N C B-55. Snow King rotary plow for truck attachment, one small plow for attachment to small size tractors and one of the large models of the Snow King. George Niess in charge.

Russell & Co.—Booth N C-12.

Russell Grader Mfg. Co.—Booths N-2, 3, 4, and 5.

Ryerson & Son, Inc.—Booth E B-14.

Sauerman Bros.—Booths S-5 and 6. Working model of the Sauermann slackline cableway excavator and a working model of the Sauerman crescent power drag scraper, both handling sand and gravel; a second Sauerman crescent drag scraper model showing in miniature how this equipment is used for stripping overburden, making cuts and fills and similar general excavating work; also actual equipment, such as scraper and cableway buckets, special blocks and sheaves, etc. F. A. Pement in charge.

Schramm, Inc.—Booth S-7. No. 120 Schramm portable engine driven air compressor. Henry N. Schramm, A. O. Witt, M. O. Washburn, T. H. Jayes, W. E Mitros in attendance.

Service Bureau, Amer. Wood Preservers Assn.—Booth B R-53.

Service Motors, Inc.—Booths N C B-10 and 14.

Servicised Products Corporation—Booth W B-22. Expansion joints, construction joints, sewer pipe joints, rail filler, crevice fillers. E. O. Seeling, A. C. Fischer, H. E. Cox, H. W. Herbst in attendance.

Sesquicentennial International Exposition—Booth B R-18A.

Shaw-Enochs Tractor Co.—Booth N C-11. Shawnee "Thirty" Grader, Shawnee Fordson Grader. C. D. Enochs, Z. H. Hutchinson, J. P. Gertsen, J. L. Becker, E. L. Edwards in attendance.

Simons Paint Spray Brush Co.—Booth N C B-6. Paint spray brush apparatus and portable air compressors, electric or gasoline. Highway marking machine for streets, ceter lining highways and for zone lines in congested city areas. Geo. W. Simons in attendance.

Simplicity Engineering Co.—Booth E B-15. Working models of portable and stationary screening machines; also ½ size of latest creation, the super screen. Lewis E. Soldan, Geo. W. Behnke in attendance.

Sivyer Steel Casting Co.—Booth S B-11. Road machinery castings in both carbon and alloy steels used in road machinery construction, such as track shoes, gears, pinions, sprockets, axles, digger teeth, etc. Arthur H. Oberndorfer, Burtner Fleeger, Freeman W. Stowe, Martin A. Fladoes in attendance.

T. L. Smith Co.—Booth 8. New 6-bag 27-E paver, a one-bag 5-S tilting mixer for bridge and culvert work and a small 2½-S trailer type tilting mixer for small repair work.

Smith Engineering Works—Booth E-14 and 15. Complete miniature rock crushing plant driven by 1 h.p. motor reducing granite rock from 1 in. to ¼ in. and under; also model washing plant equipped with water supply, centrifugal pump and all the necessary features of a full-sized gravel washing plant of the cableway excavator type, exclusive of the digging and hoisting equipment.

Snap-On Wrench Co.—Booth N C B-75.

Solvay Process Co.—Booth N C B-73. Samples of Solvay flake calcium chloride and models demonstrating its use for highway construction and maintenance; also a Solvay calcium chloride spreading machine and recently perfected automatic feeder, which is attached to the concrete mixer and which feeds calcium chloride solutions directly into the mixing chamber in the correct proportions. G. P. Spencer, H. F. Clemmer, C. M. Adams, Jr., Geo. Schroeder, H. E. Hattersley, P. M. Goodwin, R. H. Sawens in attendance.

Speeder Machinery Corp.—Booth G-20. Speeder shovel with cab. G. T. Ronk, T. M. Deal, Walter Baker, C. W. Ferguson, Carl Monroe, and W. H. Neibert in attendance.

Splitdorf Electrical Co—Booth N C B-38. Splitdorf magnetos, generators, spark plugs. O. W. Smith, W. L. Kaiser, and G. L. Lang in attendance.

The Standard Scale & Supply Corporation—Booth W-3. One bag concrete mixer non-tilter; one half bag concrete mixer tilter; one hoist; one pumping outfit. R. C. Larkin and H. S. Hawkinson in attendance.

Star Drilling Machine Co.—Booth S B-18. New Star power shovel, Photographs and literature. L. W. Breyfogle, L. A. Krupp, Geo. E. Wagner, B. C. Clutter in attendance.

Sterling Motor Truck Co.—Booth A-8. One motor truck and parts board. Wm. Reese, W. F. Wittenberg, H. L. Demerath, H. G. Metzler, R. H. Woodcock, James P. Stewart in attendance.

Sterling Wheelbrrow Co.—Booth E B-21. Contractors barrows and carts. H. H. Baker, J. J. Coyne and Leo Hartwell in attendance.

Stockland Road Machinery Co.—N C-23. New 1-man power maintainer, patrol grader, combination grader and scarifier. Cal Sivright and Collis Johnson in charge.

Stover Mfg. & Engine Co.—Booth E B-16. Industrial type engines for concrete mixers, conveyors, hoists, and all machines requiring power. M. A. Steele, Lee Madden, J. J. Ellis, F. J. Haller, R. M. Bennethum in attendance.

Sullivan Machinery Co.—Booths W-9 and 10. Three types of air compressors—2 portable and 1-semi-portable; two new types concrete breakers; new contractors compressed air drill sharpener; rotator hammer drill; clay spader. Joseph H. Brown, Raymond B. Hosken, Russell Scott, R. E. C. Martin, A. G. Crowley, W. H. Duffill, S. B. King and Robert Moth in attendance.

Superior Body Corp.—Booth N C B-1.

Taylor-Wharton Iron & S. Co.—Booth W B-4. Manganese steel castings; special alloy steel castings; "new process" mang. steel chain; also steel castings with high manganese content. J. C. Taylor, Jr., Redington Moore, H. F. McDermott in attendance.

Tennessee Tool Works—Booth N C B-44.

The Texas Co.—Booth B R-5, 6 and 7.

Thew Shovel Co.—Booth 9. New 1¼-yd. gasoline combination shovel, crane and dragline. F. A. Smythe, C. B. Smythe, A. W. Smythe, E. J. Wilson, H. C. Avery, S. R. Horner, J. B. Plunkett, E. W. Bloedorn, A. F. Kuehne, V. L. Wheeler, F. A. Rumer, R. F. Deane, B. E. Onkst, A. C. James in attendance.

The Timken Roller Bearing Co.—Booth E B-19. Miniature steel plant; display of bearings. L. M. Klinedinst, W. B. Moore, Carter Miller, George Thewlis in attendance.

Thomas Elevator Co.—Booth W-8A.

Tractor Grip Wheel Co.—Booth W B-10.

Trailmobile Co.—Booth N C-2. Trailmobile, Model "Z-5-D" roll off end dump body. H. B. Vested, James Monroe, H. M. Wood and R. B. Jones in attendance.

Truscon Steel Co.—Booths S B-6 and 7. Highway materials. B. C. Briody and W. H. Kelley in attendance.

Twin Disc Clutch Co.—Booth N B-2. Clutches, power take off units. P. H. Batten, W. I. Pearmain, R. H. Smith.

United Alloy Steel Corp.—Booth N C B-40. Corrugated metal culverts. J. T. Hay, H. J. Bair in attendance.

Universal Crane Co.—Booth N C-21. Full-circle swing, five-ton, gasoline powered locomotive crane, equipped for dragline, clam shell, hoist block, magnet and sling work, mounted on a 5½ ton, Mack truck chassis. F. A. Peck, H. A. Hutchins, Q. J. Winsor in attendance.

Universal Crusher Co.—Booth N C-9. Rock crushers on skids; model rejection crusher. W. L. H. Harrison, F. L. Shramek, L. W. Dunlap, E. A. Velde in attendance.

Universal Motor Co.—Booth S-8. Industrial engines pumping unit, electric generating sets and marine motor all gasoline driven by the Universal 2⅝x4 flexifour engine. C. H. Huesener, R. H. Garrison, C. J. Pope, R. U. Yost in attendance.

Uvalde Asphalt Co.—Booth N C B-49.

Vulcan Iron Works—Booth W-4, W-5. 12 ton worm gear driven gasoline locomotive. J. Truman Evans, L. D. Graboski, Harold Olsen in attendance.

Walter Motor Truck Co.—Booth N C B-21.

Watson Truck Corp.—Booth A-14. Watson bottom dumping wagon showing various upper box combinations obtainable for increasing capacity. This wagon will also be equipped with the latest Watson hitches for hauling wagons in train. H. J. Clark and E. W. Gay in attendance.

Waukesha Motor Co.—Booth N-6.

Wausau Iron Works—Booth G-9.

Wehr Co.—Booth G-2. Power graders, road rollers, dump body tractors. G. C. Salisbury, E. C. Myers, E. R. Wehr in attendance.

Western Wheeled Scraper Co.—Booth N C-18. New machine for grading in narrow streets and alleys. J. E. Huber in charge.

Geo. D. Whitcomb Co.—Booth W-6 and 7.

The White Co.—Booth 30. Latest model White heavy-duty dump truck and one of the standard White rear axle units showing the double reduction gear drive with working parts visible; also illuminated photographic ex-

hibit of White trucks in road building service. F. E. Triebner and Henry Jenkins in charge.

Wiard Plow Co.—Booth S B-1. Steel combination rooter and furrow plows, also light steel furrow plows. S. J. Hunt and C. C. Jaynes in attendance.

G. H. Williams Co.—Booth W-2. ¾ cu. yd. Hercules heavy duty type clam shell bucket and ¾ cu. yd. favorite type clam shell bucket; also automatic model in continuous operation. H. F. Randall, E. L. Harrington, T. D. Harter, G. E. Monroe in attendance.

Williams Patent Crusher & Pulverizer—Booth N C-7. Crushers, also operating model, photos, printed matter, samples, etc. R. F. and A. E. Schneider in attendance.

Williamsport Wire Rope Co.—N B-3, 4 and 5. C. M. Ballard, M. E. Maggart, C. W. H. Higbee in attendance.

Wisconsin Motor Mfg. Co.—Booth A-9. Gasoline engines and power units. H. M. Cronk, W. N. Fitzgerald, W. H. Brassie in attendance.

Wood Hydraulic Hoist Body Co.—Booths A-1, 2 and 3. H. Kvindlog, C. D. MacPherson, Frank H. Dewey in attendance.

Structural Design of Roads

Summary of Committee Report Presented at Fifth Annual Meeting of Highway Research Board

By Chairman A. T. GOLDBECK
Formerly with U. S. Bureau of Public Roads

Subgrade Investigations.—The most unfavorable subgrade conditions are due to excess moisture in soils that are affected thereby. Such excess moisture results from (a) poor surface drainage, and (b) poor internal drainage.

Under the most favorable climatic conditions few failures are due to the subgrade. Favorable climates involve moderate temperatures with comparatively low precipitation, and particularly low precipitation during the winter months. Unfavorable climates have long continued periods of cold weather; high precipitation during freezing weather; or frequent alternations of freezing and thawing combined with deep freezing.

Additional information on admixtures for subgrades is included in the report.

Stresses in Concrete Road Slabs.—Tests indicate that concrete, when reinforced with small amounts of steel, may be extended more without visible cracking than when unreinforced.

The extensibility of dry concrete beams was found to be less than that of wet specimens.

Deformation measurements in existing concrete roads furnish an excellent index of the load-carrying ability of the slab. The recent measurements corroborate the thickened edge design. Tests in Cook County, Illinois, indicate that a 9-7-9 section is suitable for an 8,750-lb. maximum wheel load.

It is indicated that, for all practical purposes, the stress produced in concrete pavements is directly proportional to the wheel load.

Within practical minimum limits of axle spacing, the individual axle loads of a 6-wheel truck may be as heavy as in the case of a 4-wheel truck.

Theoretical Stress Analysis.—Stresses in concrete pavements have been determined by the mathematical Theory of Elasticity closely approximating those determined by test measurement. Tables of stresses have been prepared from which it is possible to proportion the slab under given conditions.

The analysis shows that the "stiffness factor" of the subgrade does not greatly affect the pavement stresses.

Planes of Weakness Introduced in Concrete Roads.—Attention is called to a promising experiment in which an attempt is made to control the transverse cracking in concrete pavements. This is done by creating transverse planes of weakness in the pavement during construction.

Tests of Brick Paving

The U. S. Bureau of Public Roads is now conducting an investigation at its Arlington experimental station to ascertain the durability of vitrified paving brick wearing surface. On a circular track have been laid 10 sections of vitrified brick paving, the only variable being found in the depth (or thickness) of the brick. This ranges from 2 ins. by ½ in. increases, up to and including 4 ins.

The object is to determine the intensity and weight of traffic that can be withstood by the various depths of the vitrified brick wearing surface. To this end artificial impact will be introduced, and every attention given to subjecting the brick wearing surface, by means of intensified traffic, to the same sort of punishment, and in the same or greater degree, that it would get under normal use in a public street or highway.

The test pavement was completed on Nov. 16 and the Bureau started truck traffic over it on Nov. 27.

Moving Sidewalks at Paris.—The city officials of Paris, France, are to make an experimental installation of a "moving sidewalk" on one of the principal streets of the city. This moving sidewalk, fashioned after the escalator, carries traffic either way and beside each of the moving walks there is a stationary board walk for the use of those who are too timid to use the mechanical conveyance.

Two Track Brick Super-Highways

The Old and the Modern Methods of Brick Pavement Construction on the Roads of Cuyahoga County, Ohio

By JAMES R. McCLEARY
Road Engineer, Cuyahoga County, Ohio

Twenty-five years ago—before most sections of the country began to think seriously on improved highways—Cuyahoga County, Ohio, blazed the way and pioneered in putting through its first comprehensive road paving program.

Judged by present-day standards, this pioneer effort was woefuly inadequate, but at the time it was launched it won for Cuyahoga County the reputation of being the best paved county in the United States. Engineers came from all parts of the country and even from foreign lands to inspect "the latest thing in improved highways." Cuyahoga County was pointed to as a model and was patterned after by others.

The Early Brick Pavements.—Although some of these early brick pavements still are in service carrying, in addition to normal present day traffic, heavy fleets of trucks that have replaced local freight trains one one of the country's main trunkline railroads, they never were designed or built to carry anything but what today is considered "light" traffic. Their construction was accomplished some years before there was any hint of what present day traffic might amount to. Even the most visionary or far-sighted official or taxpayer hardly would have dared to predict a 5 or 10-ton truck, and certainly not so near in the future.

Only 10 and 12 ft. wide, some of these first pavements consisted of nothing more than the vitrified brick surface on the natural soil. Usually there were a couple inches of sand spread on the subgrade to perfect the alignment. A little later there were thin artificial

Superior Road, between Euclid Ave. and Mayfield Road. Each Strip is 24 ft. Wide.

bases consisting of a few inches of gravel, occasionally field stone and sometimes crushed stone. Artificial drainage never was considered, the deep ditches at the side of the road being deemed sufficient.

The ultimate in heavy design for these earlier pavements provided for a vitrified brick wearing surface 4 in. thick, a sand bedding course, and 4 in. of concrete. This was considered more than ample, in fact was supposed to contain quite a margin of safety.

Cement grout filler predominated in this early construction, although filler of gas house tar (not the tar filler of today) was sometimes used, as also was plain sand.

The Road of 25 Years Ago Built for Slow Moving Traffic.—Those of us who today are prone to criticise and perhaps censure the engineer and public official of a quarter of a century back for not designing heavier pavements and for failing to display a keener vision of future needs, have but to hesitate a moment and consider the difficulties we frequently face today in inducing taxpayers to sanction the expenditure necessary for what we consider the proper type and design of pavement for our future needs as we anticipate them.

We need only recall that 25 years ago there was no united demand on the part of 18,000,000 automobile owners for comfortable transcontinental traffic ways, no nation of tourists, no organized group of truck owners and bus operators clamoring for more and better highways, no automotive and related industries lending their tremendous influence. The big problem was to facilitate the movement of traffic from the farm to the city. This was slowly moving traffic, and, as measured by present day standards, it was light traffic. That the pavements of light design served their purpose is evidenced by the fact that many of these same pavements are still in service today, and they paid for themselves long ago. Rather than being subjects for criticism and censure, the engineer and public official of 25 years ago, who had to work harder to get an appropriation of $10,000 a mile than we have to work today to get one three or four times as large, are to be commended.

No doubt there were engineers and other public officials 25 years ago who visioned the future needs to a greater degree than the condition of some of our veteran pavements would indicate. Had such engineer or official dared to ask his constituents for $40,000 a mile to improve and pave a country highway, instead of being pointed to as a "man of vision," would have been condemned as "visionary," and there is a decided difference between the two that is more apparent in the tone of voice than in the dictionary definition.

Euclid Ave., between East Cleveland and Euclid Village. Each Strip 18 ft. Wide; Car Tracks in Center.

What a Recent Traffic Survey Showed.—A recent Cuyahoga County survey of these older pavements revealed a traffic on some amounting to 3,500 tons per day. Figuring only 300 days in the year, this would total an annual tonnage of 1,050,000. It is safe to assume that these anciently designed and constructed

pavements, built for light and slowly moving traffic, have been carrying on an average of one million tons per year for at least the last 10 years.

This survey revealed that very often the only thing holding up this heavy traffic was a 4 in. brick surface. Even in cases where a 4 in. concrete base had been specified it was found that in many spots this base had crumbled away due to the action of moisture. It must be remembered that the materials entering into such concrete years ago were not the equal of materials used today with the result that the concrete was far inferior to the present day product.

Finally, the survey showed that in those cases where the brick surfaces were laid on soil of a sandy or gravelly nature, or where the clay contained a good measure of sand or gravel, the surface today, despite the unanticipated traffic it has been called upon to carry, is many times found in as good condition as the day it was laid.

Construction Features of Two Track Pavements.—It is a far cry from a 10 ft. brick wearing surface laid on an undrained heavy clay subgrade to the modern type of two-track super-highway being constructed in Cuyahoga County today. This modern type calls for artificial drainage where needed, and soil surveys and tests are a preliminary study never overlooked. Such a thing as a soil survey was not thought of 25 years ago.

Today we find the subgrade rolled with a 10-ton roller whereas 25 years ago a light, horse drawn roller weighted down with scrap iron had to serve the purpose. Thorough and uniform compaction of the subsoil is possible today, but was quite out of the question when the first brick pavements were built in Cuyahoga County.

Upon this adequately drained and thoroughly compacted subsoil is placed either a 7-in. or 8-in. concrete artificial base, instead of a few inches of sand, gravel or crushed rock. Furthermore this artificial base is reinforced with steel and wire mesh.

Instead of being only 10 or 12 ft. wide, with a consequent concentration of traffic in one narrow path, these super-highways provide two separate traffic ways with a parked strip between, this strip sometimes containing car tracks and in other cases being beautified. Each of the traffic ways range from 18 ft. to 24 ft. in width, and only one-way traffic is permitted on each strip. Instead of being concentrated, traffic now can spread out.

Noble Road, between Euclid Ave. and Mayfield Road. Each Strip 16 ft. Wide.

Between 25 and 30 miles of this new type of double-track super-highway has been contracted for in Cuyahoga County during the last year and plans for 1926-27 call for a big addition to this mileage. The program for 1926 is estimated to cost between $9,000,000 and $10,000,000.

Thus far most of this type of construction has called for a vitrified brick wearing surface. What other types, if any, will be used has not as yet been determined.

Advantage in One-Way Traffic.—This particular design of double-track highway, with

one-way traffic only on each strip, was decided upon by County Engineer Frank R. Lander, because it is considered one of the safest, speediest and most desirable designs thus far developed to handle modern traffic.

According to tests and computations made throughout the country, two 30-foot strips each devoted to one-way traffic will carry more traffic with a lesser degree of risk than one strip 100 ft. wide and accommodating two-way traffic.

Surveys conducted on the single strip highways permitting two-way traffic show that under ordinary conditions much of the width is not in use. Then, under abnormal traffic, such as occurs during rush hours or on holidays, the center portion of the pavement becomes a veritable danger strip. Fast traffic going in opposite directions is found in the center of the pavement, and frequently collisions result.

In the case of double track-pavements, investigators seldom find three vehicles abreast. The slower traffic keeps to the right hand curb and the faster traffic has ample room to pass without being endangered by traffic coming from the opposite direction. When accidents do happen on the double track roadway it is more often the case of rank carelessness than when they happen on those types which, although they may be wider, permit traffic to travel two ways on the same strip of pavement.

Twenty-two main thoroughfares totalling 105 miles are on the program for repaving in Cuyahoga County during the next year or two. Two of these already are planned on the double track design. One of these, known as the Warrensville-Center Road, will contain two strips each tentatively planned 24 ft. wide, and will be 9 miles long. The second, known as the Mayfield Road, will have two strips each 19 ft. wide and will be 8 miles long. These two jobs alone are estimated to cost close to $3,000,000.

Because so much of the old brick yardage in Cuyahoga County is of the rigid cement grout filled type, it will be impossible to take up and use the brick over again as individual units. This form of salvage is possible, however, where asphalt or plain sand filler has been used. Asphalt filler predominates today. In case of the grout filled pavements in Cuyahoga County, where reconstruction becomes necessary for any reason, the old pavement, where suitable, will be utilized as a part of the artificial base for the new construction. In many cases it is figured this salvage value, considering present day prices, is greater than the original cost of the pavement to the taxpayers. In short a modern concrete base as durable as that provided by the old 4 in. base plus the old 4 in. grouted brick slab would cost more today than the old brick pavement did originally.

Trunk Highways for Trucks

Trains of tractors and trailers controlled by air brakes and operating on a regular dispatching service over special trunk highways were pictured as a development of the future by Major Elihu Church, transportation engineer of the Port of New York Authority, in an address delivered at a meeting of the Metropolitan Section of the Society of Automotive Engineers in New York City recently.

These trunk higways will be toll roads, he said, and will be laid out with the same care as to grades and curves as the railroads. They will be lighted, will be provided with telephones at frequent intervals, and there will be a regular wrecking and repair service. Trailer trains and convoys of trucks will be dispatched on regular schedules, largely as the army transport was handled in France during the war. Except where the roads enter cities on a second level above main railroads, they will pass around cities and towns as belt roads, so that the traffic on them will not pass through dense local traffic, and they will be carried over or under transverse roads. They will be built with capital invested by farmers and others interested in the development, as toll roads formerly were built.

The necessity for such roads will grow out of the increasing traffic congestion on the present highways and the inadequacy of the present highways to accommodate the light, fast passenger vehicles and the slow, cumbersome motor trucks at the same time.

Traffic Regulations of 1757

According to the National Motorist officials of Boston, Mass., had their traffic troubles far back before the days of the Revolution. Here is a quaint ordinance adopted by the selectmen in 1757:

"Owing to great danger arising oftentimes from Coaches, Slays, Chairs, and other Carriages, on the Lord's days, as people are going to or coming from the several churches in this Town, being driven with great Rapidity, and the Public Worship being oftentimes much disturbed by such Carriages, it is therefore Voted and Ordered, that no Coach, Slay, Chair, Chaise or other Carriage, shall at such times be driven at a Greater rate than a foot Pace, on Penalty to the Master of the Slave or Servant, so driving, of the Sum of ten shillings."

Surface Treatment of Gravel Streets

Methods, Materials and Equipment Employed at Cuero, Tex.

By O. F. REYNAUD
Of The Texas Co.

Cuero, the county seat of Dewitt County, in south Texas, has in the neighborhood of 14 miles of smooth and durable pavements constructed at a minimum of cost and by a handful of workers.

It is the purpose of the writer to give in detail the method of construction of the surface treatment on Court House St., the oldest paved street in Cuero, as it serves as an example of the method followed throughout the city. In 1905 this street was first gravelled, the material used being a pit run bank gravel, containing between 20 and 25 per cent of clay, so applied as to give a compacted thickness of approximately six inches. In this stage of the work, traffic served to compact the gravel. No further material was added until 1920, when it was planned to prepare Court House and other streets for a surface treatment. In that year, two treatments with liquid asphalt were made, 30 days apart, and since then no further treatments have been necessary.

View of Court House St., Taken September, 1925. Street Received Two Treatments of Liquid Asphalt in 1920.

Building Up the Base.—The street was roped off from traffic until after the initial tratment was entirely completed. New gravel was dumped on the old, wetted and then graded with a steel blade grader drawn by a tractor. In the opinion of the street supervisor of Cuero, the best time to build up the base is when the new material is moist. It must not, however, be sloppy. A shower oftentimes gives the new gravel the necessary wetting.

After the grading was completed, a roller weighing 10½ tons compacted the new material so that the base had a thickness of approximately 6 in. on the sides and 10 in. in the center. The surface was rolled and rerolled until a maximum of compaction was secured. The idea was to approximate as closely as possible a waterbound macadam surface.

The street was then allowed to stand at least four days exposed to the sun to allow the moisture to evaporate slowly. No traffic was permitted during this period. The dry, compacted surface was then thoroughly broomed with steel brooms to remove any dust or loose material, leaves, etc., which might have accumulated.

Initial Application of Liquid Asphalt.—While the street was being broomed, Texaco liquid asphalt No. 1, containing approximately 60 per cent of asphalt, was being heated in a distributor near the scene of the work, to about 180° F. Torpedo sand had been piled at intervals along the curb so as to facilitate covering.

Upon the clean surface the hot asphalt was applied by pressure distributor in an even spray at the rate of ¼ to ⅓ gal. to the square yard. The distributor was provided with proper gauges and flow control. Care was taken that it moved at a uniform rate of speed to assure uniform distribution.

Immediately following this, a crew of workmen equipped with shovels, spread the torpedo sand over the asphalt at the rate of about 1 cu. yd. to 90 sq. yd. of surface. The idea of immediate covering was to prevent the sun from having a "drawing" effect upon the asphalt, or causing the volatile materials therein to begin evaporating before the penetration of the asphalt into the surface began. The street was allowed to stand a few hours before traffic was permitted to use it.

The Second Treatment.—After a lapse of approximately 30 days, the street was again roped off and prepared for the second treatment. Fibre brooms instead of steel were used this time to remove any dust or loose material. It was essential to exercise care in order that the thin coat of asphalt and sand formed by the first treatment should not be

broken. Traffic had "ironed out" the first application to a certain extent. In a few places there appeared to be "weak" or "lean" spots occasioned either by an insufficient use of asphalt or too little cover material. Before these spots could be broken, they were treated with a small amount of hot asphalt and covered with torpedo sand as in the initial treatment.

After the brooming, hot asphalt, heated to about 160° to 170° F. was applied as before by pressure distributor at approximately the same rate, ¼ to ⅓ gal. per square yard, and immediately covered. This time the street was opened to traffic at once.

was used entirely. The new patch was tamped until firm and well compacted. The asphalt caused the patch to bond readily with the adjacent surface. To date, however, Court House St. has required little patching. When asked if continuous patching had been necessary, those in charge replied, "No, there is no need, and other than at intersections there is very seldom any signs of wear. Three men can easily handle whatever maintenance becomes necessary."

The Cuero streets have the appearance of asphaltic pavements and stand up exceedingly well under traffic. In one instance, a truck with 3-in. steel tires, bearing a 10-ton metal tank, passed over one of the surface-treated streets, leaving a depression of less than ¼ in. This depression ironed out under traffic within a short time.

View of East Main St. Two Treatments of Liquid Asphalt Applied in 1920; Third Treatment in August, 1922. Photograph Taken September 4, 1925.

Maintenance.—The secret of success in surface treating lies in careful maintenance. Proper maintenance entails an inspection at frequent intervals and the immediate repair of any depressions or "pot holes" that traffic might develop.

For the purpose of maintenance, Cuero secured a quantity of crushed limestone rock ranging in size from about ¾ in. down, with dust removed. In case a pot hole was discovered, it was immediately cleaned out by hand, liquid asphalt was used to paint all around the hole, and a small quantity was poured into it, followed by stone. Where the hole was an inch or more in depth, ¾ in. stone was first spread and covered with stone of a smaller size. For shallow holes, smaller sized stone

Equipment.—In order to properly carry out the work described above, Cuero used the following equipment:

For preparation of the base—Blade grader, a 10½-ton roller, tractor for drawing grader and roller.

For preparation of surface for hot asphalt treatment—Steel brooms.

For application of asphalt and covering—A 600-gal. asphalt distributor, hand shovels, fibre brooms.

For maintenance—Buckets, brushes, tamper.

Super-Highway Construction at Detroit

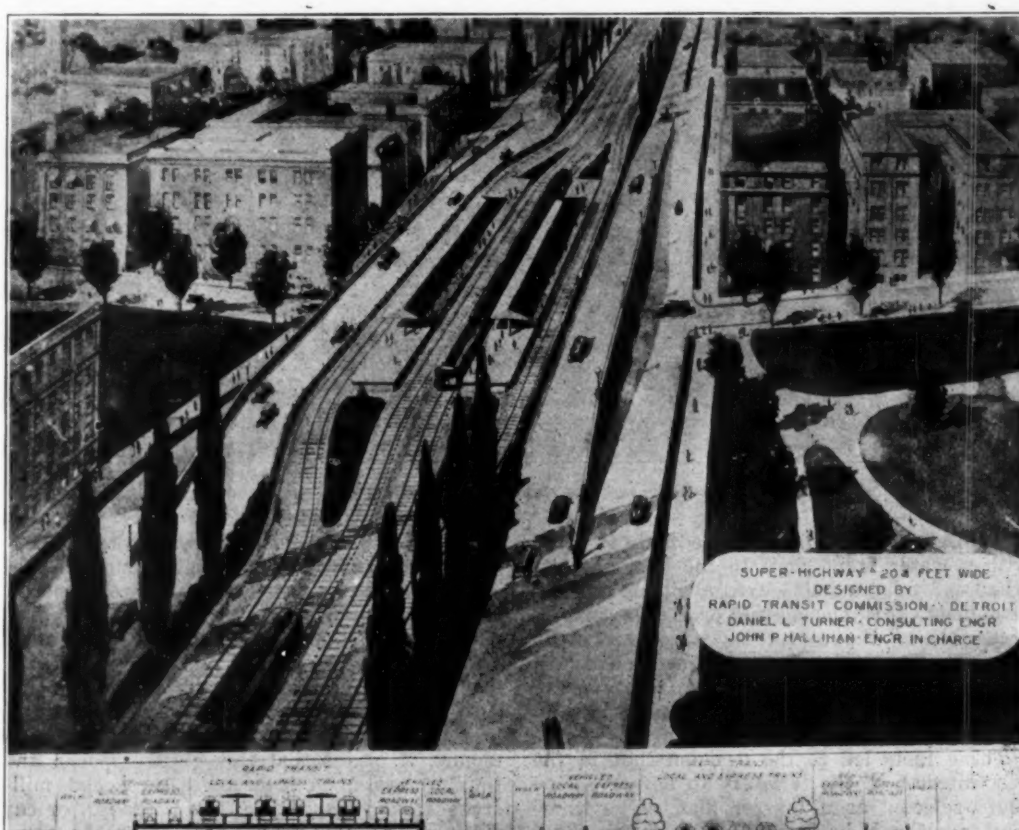
Plans for Future Transportation Requirements of Detroit Described in Address Presented December 3 Before Chicago Regional Planning Association

By COL. SIDNEY D. WALDON
President, Detroit Rapid Transit Commission

In the plans for Detroit's future transportation requirements the automobile, representing the individual's rapid transit on rubber, and electric trains, giving rapid mass transportation on rail, have been considered together.

The automobile is recognized as the pioneer transportation agency in developing remote sections, with busses and street cars following, to carry the major load. Ultimately any section, or all sections, may reach a condition of population density requiring the fullest development of train operated rapid transit, with its natural complement of street car and bus line feeders. To provide for this ultimate development necessitates the making of a comprehensive plan of routes extending to the limit of the Metropolitan Area and so designed as to serve all sections equally.

Great concentrations may occur anywhere within the metropolitan area and the routes should be so spaced, and of such width, as to take care of them. For instance, on Detroit's western border is the City of Springwells, having an area of $1\frac{1}{3}$ square miles, with a resi-



Proposed Super-Highway 204 ft. Wide, Designed by Detroit Rapid Transit Commission

dent population of 5,000 and a working population of 70,000.

Areas of Accessibility or Collective Rail Transportation.—Collective rail transportation can be considered to have three areas of accessibility when measured by a total travel time of 45 minutes, including a short walk at each end of the route.

Street cars, with a radius of 5 miles.

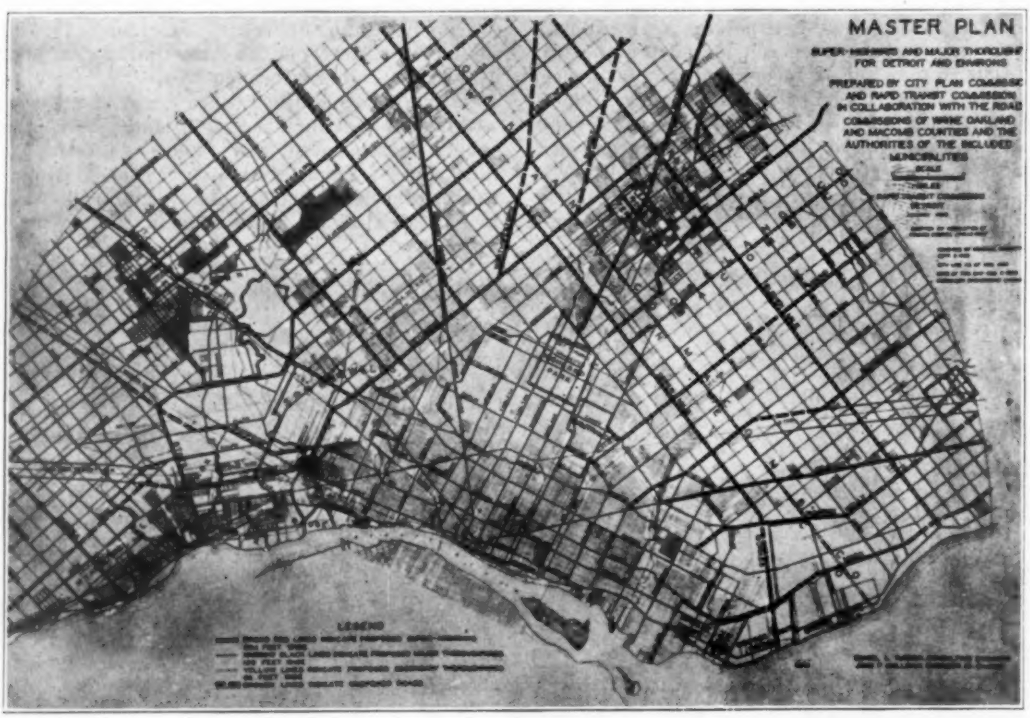
Local service rapid transit, with a radius of 10 miles.

Express service rapid transit, with a radius of 15 miles.

ft. of surface space for pedestrian, individual and collective transportation.

Two ways of accomplishing this are apparent. The four tracks can be built beneath the 120 ft. street, or in the outlying sections the 120 ft. can be split, and 80 ft. laid on each side of four surface rapid transit tracks. This, of course, requires that suitable grade separations be provided at ½-mile intervals to take care of cross traffic.

The width, 120 ft., permits the housing of four rapid transit tracks, main sewers and other sub-surface public utilities below ground, without interfering with the foundations of



Master Plan of Super-Highways and Major Thoroughfares for Detroit and Vicinity

As Detroit and Chicago are both situated with a water front close to the business district, and only a half circle available for development, this means that the area that is accessible to the center by street car is 39 square miles; the local rapid transit makes 157 square miles accessible, while the express rapid transit brings 353 square miles within the same travel time of 45 minutes.

These facts led to the decision that in the best interest of the territory to be served, no route selected as a master plan major thoroughfare should be developed to a lesser width than sufficient to provide an ultimate capacity of four rapid transit tracks, together with 120

adjoining buildings. In New York, particularly, four track subway construction has frequently had to encroach upon private property, requiring the underpinning or rearranging of parts of the foundations of large buildings, resulting in heavy expense, in one instance amounting to 25 per cent of the cost of the subway itself. Such extra expense is a total loss. If financed out of city or transit bond money, it means that this extra expense and the interest upon it becomes an added millstone around the neck of the taxpayer, or car rider as the case may be, whereas the same money spent in acquiring aditional width of street would pay dividends in light and air,

and increased usefulness to all of the people throughout all time.

204 Ft. Standard Super Highway Width.—When the four tracks are brought up onto the surface, at the edge of the present built-up area, and sewers, etc., are still left below ground, only 84 ft. is required for the rapid transit facility. Placing 60 ft. upon each side for street space makes the 204 ft., which has been adopted as the standard super highway width.

The basis of the suburban portion of the master plan has been to grid the area extending from the 6 to 15 mile cricles with radial, east and west and north and south super highway routes approximately three miles apart. Beyond this outer limit the state is extending the radials and trunk line roads to the next town or city. In this manner several cities 25 to 30 miles away will have continuous 204 ft. double track super highways, making direct connection between those cities and the so-called Detroit system, which in itself comprises 217 miles, divided as follows:

109 miles in Wayne County—outside of Detroit
40 miles in Oakland County
37 miles in Macomb County
31 miles within Detroit's city limits.

In between the super highways the mile section line roads have been standardized at 120 ft.; the half-mile or quarter section roads at 86 ft., and residence streets at 60 ft.

This means that any section may develop through the use of the automobile, the motor bus and street car, up to the condition requiring rapid transit. It means that at this point train operated Rapid Transit can be provided along the Super Highways at approximately $2,000,000 per mile less than underground construction. In other words, the area can have Rapid Transit earlier, or can have more for the same money.

It further means that every 120 ft. section line road will be capable of housing four rapid transit tracks under ground, and the 86 ft. half-mile roads two underground tracks. When all of these possibilities are used up, there will still remain the untouched sub-surface space in the 204 ft. super highwaws, within, which, by proper adjustment of stations, eight rapid transit tracks could be laid abreast.

How the Plan Is Being Accomplished.—The plan is being accomplished in the following ways:

Super Highways:

County Boards of Auditors. Through acceptance of Plats conforming to the roadway widths of the Plan.

Private Property Associations. Working to obtain dedications along routes in which they are particularly interested.

State. Acquiring right of way and improving, as on Woodward Avenue, etc.

Super Highway Commission. Acquiring land for right of way only.

Mile Section Line Roads and Quarter Section Line Roads:

County Boards of Auditors. Through acceptance of Plats conforming to the roadway widths of the Plan.

County Road Commissions. Acquiring right of way and improving as required.

Super Highway Commission. Acquiring only right of way.

City Thoroughfares:

Set back building lines.
Condemnation.

Super-Highways and Roads in Vicinity of Detroit

Of the various methods of acquiring rights of way, the most effective and least expensive is the dedication, according to the standards of 204, 120, 86 and 60 ft., that owners automatically make when their plats are accepted by the boards of auditors of the Counties of Wayne, Oakland and Macomb.

It is not uncommon on summer holidays to have traffic streams in both directions backed up for 10 to 15 miles on our 20-ft. wide pavements. Nowhere was this worse a year ago than on Woodward Ave., and the relief that has come about as the result of the state's

improvement of this road as a double-track super highway, has permanently sold the plan to the people.

Agencies Working for Accomplishment of Plan.—It is also remarkable that private property owners and real estate organizations have done towards making the 204 ft. rights of way available. Even though the Plan is less than two years old, one can drive for miles and miles on some of the routes and see, back in the fields, the lot stakes and sidewalks marking the 204 ft. reservations.

First Completed Unit of Super-Highway from Detroit to Pontiac, Mich.
The 44-ft. Pavement in the Foreground eventually Will Carry Traffic in One Direction Only. Beyond This Will Be a 40-ft. Zone for Electric Tracks, then Another 44-ft. Concrete Pavement for Vehicular Traffic in the Other Direction. Several Miles of Both Roadways Already Are Completed.

In addition to the above agencies working for the accomplishment of the plan, there has been set up under an act passed at the last session of the legislature, two super highway commissions, each made up of the six road commissioners of two counties, plus the state highway commissioner. These super highway commissions are granted power, subject to the approval of the boards of supervisors, to use not to exceed the proceeds of a ½ mill tax for the acquisition of right of way only.

These super highway commissions have no power to improve such right of way, but only to acquire it. The improvement remains the duty of the road commissioners of county or state.

The actual improvement of these rights of way, while important enough, is not so vital to Detroit and the metropolitan area as is the acquisition of the land itself. What can be obtained now largely through the existence of the plan, and the educational work that is being put back of it, or at relatively modest cost through the state and county authorities, would cost untold millions 10, 15 or 20 years hence. All differences are swept aside in the universal agreement that the width is necessary and should be nailed down now.

Safeguarding Through Traffic.—Granting that rapid transit can be constructed upon the surface, with grade separations every half mile, at a cost of $2,000,000 a mile less than a subway, and that the city's tracks are extended down the center of these super highways, then there will become possible a motor vehicle facility for safe rapid transit on rubber that does not now exist anywhere in the world.

No pedestrian and no vehicle will ever cross the express roadway, because it is placed next

to the transit right of way, and passes over all separated intersections. Entrance to and exit from it will be provided at frequent intervals, but so placed as to safeguard the through traffic, as well as the entering vehicle. Travel upon the express roadway, being subject to no "Stop and Go" regulation, pedestrian or cross traffic interference, still move continuously throughout the length of the super highway route.

This particular development of the super highway will restore to the motor vehicle all of the efficiency that it has lost in our congested districts and heavily traveled narrow highways. It will bring to the territory traversed an asset in individual transportation that is unique.

Effect on Older Sections of City.—This system of 86, 120 and 204 ft. main arterial rights of way, forming a net work between the 6 and 15 mile roads, with radials, of the full width, extended in some instances to the 25 and 30 mile circles, calls for special consideration of the older sections of the city, designed long before these two new requirements of the motor vehicle and rapid transit were dreamt of. Either the older sections must be opened up by widened main arteries at regular intervals, or they will suffer by reason of the bottle necks that will throttle their growth.

In rapidly growing cities the average life of buildings is about 33 years, which means that during 15 to 25 years a very large percentage of the old structures now existing will have been replaced on the new setback lines, and only a relatively few modern structures will have to be cut back at the city's expense.

It is a sad commentary upon the processes of condemnation that they accomplish their results in the most unbusinesslike manner, and at the greatest possible expense to the community.

Development follows lines of transportation. The highest value land, and the most expensive buildings, front upon the transit street. To widen the street by condemnation usually requires the community to pay for the highest value land frontage, and to largely destroy the most expensive buildings. When the operation is completed, the cheaper land, which was formerly in the rear and which now fronts upon the widened thoroughfare, steps into the same position of value as the former street, and acquires a new value by reason of the widening. The widened street attracts a better building development, but the reduced depth of the lots is less favorable to large structures. In every way the result is diametrically opposed to the city's and the property owner's best interests.

Financing the Proposition.—At the last election, Nov. 3rd, the people of Detroit overwhelmingly approved a charter amendment designed to correct in considerable measure all of these faults. It will permit the common council to create improvement districts; to condemn property other than that actually required for the widening; to readjust lot and alley lines; to exchange one piece of property for another, and in general to exercise the rights of a proprietor in the transaction.

The financing of these city condemnation cases will be taken care of on the basis of approximately ⅔ against the benefitted property, in an assessment district running back on each side of the thoroughfare widened, and ⅓ upon the city at large.

To finance the city's share, the people approved, Nov. 3rd, a Charter Amendment by which a one mill tax ($1 per $1000 of assessed valuation) upon the city at large will be used to create a sinking fund to meet the city's proportion of the cost of these cases. Such a one mill tax will raise between $45,000,000 and $50,000,000 in 15 years, and this amount, in addition to the two-thirds that is to be placed upon the assessment districts, will finance street opening and widening projects totaling $135,000,000 to $150,000,000 within the 15 year period.

State Super Highway projects are financed wholly out of motor vehicle fees. Acquisition of right of way by the Super Highway Commissions will be financed by the not to exceed ½ mill general property levy within the Counties of Wayne, Oakland and Macomb. Wayne County's road and bridge program is financed approximately ½ out of its share of motor vehicle taxation, and the other ½ out of a $1.00 per $1000.00 county tax.

When first proposed it was considered impossible. Today it is looked upon as the only practical solution of our two new transportation problems.

Salvaging Old Stone Road Surfaces

Door and Kewaunee Counties, Wisconsin, have evolved a scheme for salvaging the old road surface and making a brand new one therefrom. This is accomplished by means of a portable crusher, and briefly the method is as follows: The old road surface is scarified and harrowed until all the large stones are pulled to the surface. They are then raked to the sides of the road. The portable crusher proceeds up one side of the road and down the other, crushing the material, which is immediately placed back on the road surface. According to Badger Highways, in this manner from 300 to 500 yards of new material is placed per mile at a cost of approximately $1.00 per yard.

Progress in Federal Aid Highways

Status of Work at Close of Fiscal Year Given in Report Submitted to U. S. Department of Agriculture

By THOS. H. MacDONALD
Chief, U. S. Bureau of Public Roads

By completing 11,328.6 miles of Federal-aid roads during the fiscal year ended June 30, 1925, the cooperating Federal and state governments established a new record. The greatest mileage previously completed in any one fiscal year was the 10,247 miles completed in 1922. The new record exceeds by 30 per cent the mileage completed in the fiscal year 1924, and by more than 50 per cent the aggregate mileage completed during the first five years of work under the Federal-aid plan.

The year's work brings the total of mileage completed since the passage of the first Federal-aid road act in 1916 up to 46,485.5 miles; and in addition to the mileage completed a great deal of work has been done on the 12,462.6 miles which at the close of the year were under construction. The program of work thus far undertaken includes the above mileage completed and under construction and an additional 2,181.6 miles approved for improvement with Federal aid but not yet placed under construction. Including this latter mileage the program of Federal and State cooperation in road building as definitely planned or completed to date involves 61,129.7 miles, of which all but 3,570 miles undertaken prior to the passage of the Federal highway act in 1921 are included in the interstate or Federal-aid highway system designated in accordance with the provisions of that act.

Federal-aid Highway System Two-thirds Improved.—The mileage of the Federal-aid highway system is limited by law to 200,349 miles, which is 7 per cent of the total mileage of highways in the United States at the time of the passage of the Federal highway act. Up to the present the system as designated includes only 178,797 miles. Of this mileage, as indicated above, approximately 57,560 miles has already been improved or undertaken for improvement with Federal aid. As the states alone, without Federal assistance, have completed or have under construction an additional mileage on the system amounting to over 65,000 miles, it will be seen that approximately two-thirds of this system, designated since 1921, is already completed or under construction. When the system was designated it was hoped that its improvement could be completed within 10 years. At the present rate it is apparent that this hope will be realized and that within five more years, if nothing happens to retard the progress, there will be a continuous interstate highway system connecting every city of 5,000 population or larger, and every section of it improved to a degree consistent with the density and character of the traffic.

The year's mileage completed constitutes a varying percentage of the Federal-aid highway system in the several groups of states. As the designated system is in all states practically the same percentage of the total mileage of highways, and as in all states it includes the most important highways, the ratio of the mileage of Federal-aid roads completed during the year to the mileage of the system in each state or group of states may be taken as the index of the rapidity with which the highways of the section are being improved with Federal aid.

Analyzing the year's record in this way it appears, as shown in Table I, that the most rapid progress toward the completion of the Federal-aid system with Federal participation was made in the West South Central States, where the mileage completed during the year was 8.6 per cent of the total mileage of the system. In these states the progress of the cooperative construction would, if continued at the same rate, without other construction, result in the completion of the Federal-aid system in less than 12 years.

Compared in the same manner with the mileage of the Federal-aid system the year's progress in the cooperative work by other groups of states is indicated by the precentages shown

Table I—Federal-aid mileage completed during the fiscal year 1925 compared with the mileage of the Federal-aid highway system by groups of States

Group of States	Federal-aid roads completed Miles	Federal-aid highway system Miles	Portion of Federal-aid system improved with Federal aid Per cent
New England	256.2	5,789	4.4
Middle Atlantic	571.4	9,879	5.8
South Atlantic	1,272.7	21,155	6.0
East North Central	1,293.7	25,740	5.0
West North Central	2,561.3	46,435	5.5
East South Central	1,149.8	14,020	8.2
West South Central	2,096.1	24,282	8.6
Mountain	1,626.2	21,308	7.6
Pacific	501.2	10,189	4.9
Total	11,328.6	178,797	6.3

in the third column of Table I. Ranked in the descending order of percentage improved during the year the several groups are: West South Central, 8.6 per cent; East South Central, 8.2 per cent; Mountain, 7.6 per cent; South Atlantic, 6 per cent; Middle Atlantic, 5.8 per cent; West North Central, 5.5 per cent; East North Central, 5 per cent; Pacific, 4.9 per cent; New England, 4.4 per cent.

Forty-three per cent of the mileage completed during the year was built in the 16 states which comprise the East and West South Central and Mountain groups. These states, almost without exception the largest in the country, include 49 per cent of the total land area of the United States. Somewhat later in commencing the improvement of their roads than the other States, they are now making rapid progress in the building of their main highways with Federal aid. Fortunately their highway traffic is still considerably lighter than in other states and they are able, therefore, to build a greater mileage of satisfactory highways at a given cost than the other states. This is indicated by the fact that while their completed mileage was 43 per cent of the year's total, the total cost of the roads completed was only 35 per cent of the total cost of all roads completed with Federal aid during the year.

Federal Aid a Vital Factor in Central and Mountain States.—The degree to which the states of the several groups are dependent upon Federal participation to enable them to carry on the work of highway improvement is indicated by Table II in which the mileage of Federal-aid roads completed during the fiscal year 1925 is compared with the total mileage of highways constructed under the supervision of the state highway departments during the calendar year 1924. Unfortunately the data are not available which permit this comparison to be made on the basis of exactly the same period, but the difference in time is not great enough to be material.

It is apparent from Table II that the Federal assistance is a very important factor in the East and West South Central States and the Mountain States where the Federal-aid roads constitute from two-thirds to three-quarters and more of the annual program of construction. In the Middle Atlantic and East North Central States the percentage of roads built without Federal assistance is highest, being more than two-thirds of the annual program in each case, whereas, for the country as a whole the Federal-aid program is practically half of the annual construction program carried on under the state highway departments.

While the Federal aid is thus shown to be in all states a considerable factor, invaluable to some and helpful to others, the fact that in all groups of states from a fifth to two-thirds of the highways improved under the supervision of the state highway departments are built with state funds entirely without Federal participation is sufficient to indicate that the offer of Federal assistance has not had the effect of inducing the states to spend a greater sum for highway improvement than they would otherwise have found expedient.

The Year's Record by Types of Construction.—The mileage completed during the fiscal year, classified according to type of construction, is shown in Table III.

Classified in a similar manner by groups of States the completed mileage is analyzed in Table IV.

These tables give evidence of the economy that has been exercised in the choice of types of construction. Almost a fifth of the roads built during the year were merely graded and drained; three-fifths were of the character described as low types. As will be seen from Table IV the roads of this character have been built in those sections where traffic is still comparatively light; and in those sections they are regarded as merely the first stage of a more durable improvement which will follow as the traffic demands require it. The heavy mileage of the gravel type is especially noteworthy. This type has been found to give excellent service under automobile and light truck traffic to a maximum of about 500 vehicles a day, and

Table II—Federal-aid mileage completed in fiscal year 1925 compared with total mileage completed in 1924 by the State highway departments

Group of States	Federal-aid mileage completed, fiscal year 1925 Miles	Mileage completed by State highway departments, 1924 Miles	Ratio of Federal aid to total State program Per Cent
New England	256.2	622.9	41.2
Middle Atlantic	571.4	1,878.1	30.4
South Atlantic	1,272.7	3,240.7	39.3
East North Central	1,293.7	4,259.3	30.4
West North Central	2,561.3	5,079.3	50.5
East South Central	1,149.8	1,525.6	75.5
West South Central	2,096.1	3,187.1	65.7
Mountain	1,626.2	2,075.3	78.5
Pacific	501.2	1,295.7	38.6
Total	11,328.6	23,164.0	49.0

Table III—Mileage of Federal-aid roads completed in fiscal year 1925, by types of construction

Class and type of construction	Completed during fiscal year 1925: By types Miles	By classes Miles	By classes Per cent
Low:			
Graded and drained	2,064.1		
Sand-clay	718.8	6,985.8	61.7
Gravel	4,202.9		
Intermediate:			
Water-bound macadam	129.2		
Bituminous macadam	911.9	1,041.1	9.2
High:			
Bituminous concrete	341.3		
Portland-cement concrete	2,806.4	3,255.0	28.7
Brick	107.3		
Bridges	46.7	46.7	.4
Total	11,328.6	11,328.6	100.0

Table IV—Mileage of Federal-aid roads completed in fiscal year 1925, by classes and groups of States

	Class of construction							
	Low		Medium		High		Bridges	
Group of States	Miles	Per cent	Miles	Per cent	Miles	Per cent	Miles	Per cent
New England	48.8	19.0	113.6	44.4	91.9	35.8	1.9	.8
Middle Atlantic	1.6	.3	50.4	8.8	519.3	90.9	.1	...
South Atlantic	671.8	52.8	124.3	9.8	469.6	36.9	7.0	.5
East North Central	224.9	17.4	71.0	5.5	996.4	77.0	1.4	.1
West North Central	2,110.5	82.4	43.2	1.7	402.6	15.7	5.0	.2
East South Central	753.2	65.5	292.2	25.4	102.5	8.9	1.8	.2
West South Central	1,346.9	64.2	320.6	15.3	406.4	19.4	22.2	1.1
Mountain	1,494.7	91.9	5.0	.3	120.8	7.4	5.7	.4
Pacific	333.4	66.5	20.7	4.1	145.5	29.1	1.6	.3
Total	6,985.8	61.7	1,041.1	9.2	3,255.0	28.7	46.7	.4

it has the further advantage that it adds greatly to the life of any pavement which may subsequently be laid upon it. As suitable gravel is widely distributed in nature this type can be built at a very reasonable cost in most places.

The high-class pavements of bituminous concrete, Portland cement concrete, and brick are shown to have been constructed mainly in the Middle Atlantic, East North Central, New England, and Pacific States. It is only in these States that the traffic has developed to the point where such expensive surfaces are generally required even on the main roads. The small mileage of waterbound macadam constructed is due to the fact that this type, formerly the standard, is not suitable for motor vehicle traffic. In practically all cases the roads of this type which have been constructed will be surface-treated with bituminous material within a year to protect them from the disintegrating action of the pneumatic tires of automobiles.

Nearly 50 Miles of Bridges Completed.—It is especially interesting to note that the bridges completed during this fiscal year reach the impressive total of 46.7 miles in length. All these bridges are more than 20 feet in span and many of them cross major streams. More than a hundred miles of such structures have been completed with Federal aid since 1917 and projects have been approved for the construction of others which will add another 50 miles to the total length.

Federal Expenditures Less Than 10 Per Cent of Total.—The total cost of the 11,328.6 miles completed during the fiscal year was $242,937,488. The Federal share of the cost was $111,304,737. These expenditures were made over the period of approximately two years required to bring the projects to completion. They do not represent the annual expenditure for Federal-aid construction. The actual disbursements of the Federal funds to the states during the year were $95,749,998. These disbursements were made partly on account of the projects reported as completed during the year and partly in the form of progress payments for projects still under construction.

The Federal expenditure this year closely approaches an annual rate of $100,000,000. That such a sum does not remotely approach the point of extravagance is indicated by the fact that it is not more than 10 per cent of the whole annual expenditure for highways by all units of government.

In the sparsely settled states of the West the Federal participation is a vital necessity and a definite obligation. The sections of the Federal-aid system in these States partake more of the character of interstate or national roads than of roads for local traffic. The mileage to be improved is so great that without the Federal contribution the work could not be done in a generation; and to this reason there is added the still more compelling one that is involved in the ownership of vast areas of lands by the United States which are not taxable by the States.

But the necessity for Federal participation in highway construction does not lie alone in the Far West, nor even in the Middle West and South. It is even more essential that a continuous and adequate system of highways be built in the more populous sections of the East. There is a totally erroneous impression that the roads in the East have generally been built. It is true that road improvement was begun in that section at an early date and many miles of road were built, but every mile of the original construction is being rebuilt to meet the requirements of the greatly increased traffic, and the Federal funds are as eagerly used in this section as in any other.

There is a service which should be rendered to the people of these States in particular which can not be rendered by the State governments acting separately and alone. It must be remembered that the population around the borders of the states is no less dense than in their interiors. Between the border populations of contiguous states there is a commerce which is interstate in character, though actually local in range. Nevertheless it can only be served by the unbroken continuation of roads from each state into its bordering states. It is this object, now being rapidly accomplished with Federal assistance, that the several states acting separately and alone could not have accomplished. And the Eastern states have benefited to a marked degree by this Federal service for the very reason that their population is dense and that the number of interstate roads is great. •

How to Get Good Joints

Suggestions on Important Point in Concrete Pavement Construction Given in Paper Before American Society for Municipal Improvement

By H. ELTINGE BREED
Consulting Highway Engineer, New York City

Finishing is a most important factor, for a smooth pavement has to resist only a moving load, while a pavement which is uneven has to endure also the highly destructive force of

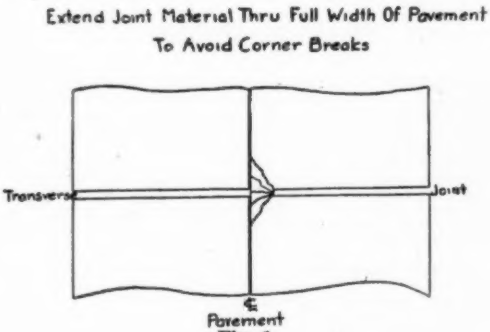


Fig. 1

impact. Proper finishing includes cutting through and rounding all joint spaces. (See Figs. 1 and 2.)

Poor joint construction or no joints at all is one of the greatest sources of trouble both early and small and large and late. Concrete, by its very nature, has the characteristic of extensibility, increasing and decreasing in length. Dr. W. K. Hatt, Purdue University, and other scientists have shown definitely through their researches that there is expansion (increase in length) in concrete pavements.

Some studies have shown that the tendency

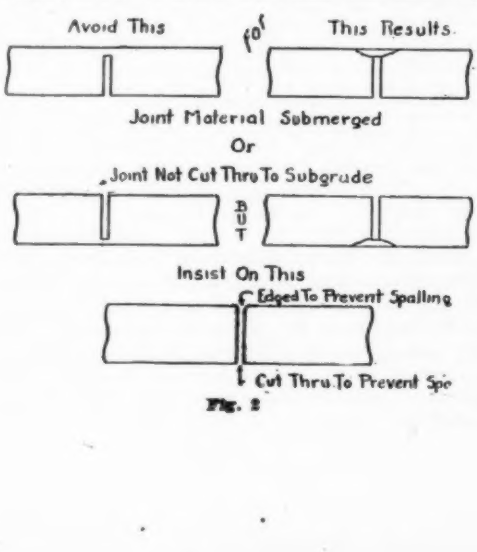


Fig. 2

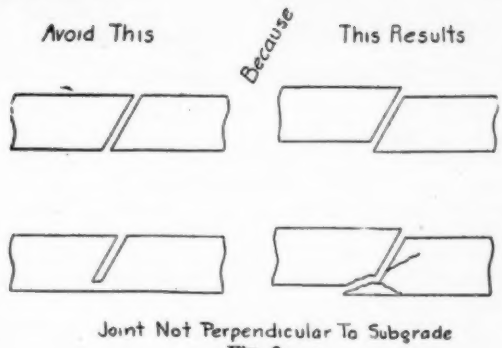


Fig. 3

of concrete is to hold some of each increase in length over subsequent periods of construction, so that part of the expansion is cumulative. When no expansion joints are provided, very high stress is set up; the concrete either expands laterally up to its elastic limit, or ruptures along its weakest parts. The rupture may not appear the first year, but frequently shows the third and fourth.

After some experiences of this kind, which showed first in blow-ups, our construction was changed to allow more expansion, and an extra joint 1½ in. wide was provided every 750 ft. Work done in 1917 with this allowance is ex-

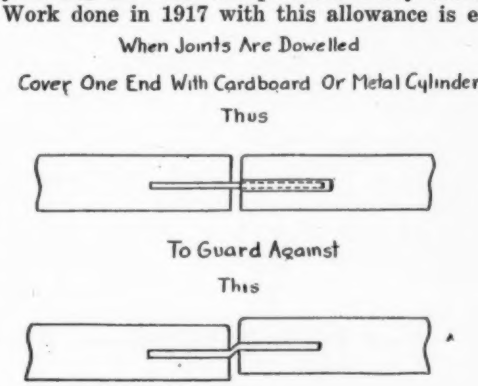


Fig. 4

cellent today, while pavements built a year or two earlier with less expansion have shown a decided tendency to crack.

Other sources of trouble with joints are: (1) the submerged joint which on compression spalls out on top (see Fig. 2); (2) the joint which is not perpendicular to the pavement surface and which when pressure comes, rides above the adjoining slab (see Fig. 3); (3) the dowel joint (see Fig. 4) which unless one free end is provided, causes the dowel to buckle and spall out the concrete or raise one slab above the other; and the failure to carry a joint entirely through the concrete which on account of concentrated pressure, shatters the concrete.

H. F. Clemmer Leaves Illinois Highway Department

H. F. Clemmer, Chief of the Bureau of Materials of the Illinois Highway Division, has announced his resignation effective Jan. 1st, to become associated with The Solvay Process Co., as technical adviser to the Calcium Chloride sales department. This announcement marks the loss from the ranks of state highway officials of one of the foremost testing engineers of the country.

Mr. Clemmer has for many years been identified with investigational and testing work of structural materials. He studied Civil Engineering at Iowa State College and after graduation spent several years on the staff at that institution and that of the Iowa Engineering Experiment Station.

Shortly after the enactment of legislation in Illinois, providing for the construction of concrete pavement under the 60 million dollar bond issue, Mr. Clemmer became Engineer of Materials of the Illinois Division of Highways and in this capacity has developed an organization of nationally known reputation. During this time he developed researches in concrete aggregates and curing methods with calcium chloride as well as studies in the physical properties of concrete, plain and reinforced. Mr. Clemmer had direct charge under Clifford Older of the investigational work carried on in the famous Bates Road Tests.

Although he is leaving the ranks of highway officials, Mr. Clemmer expects to keep in touch with research in highway design and materials, and will carry on investigations in regard to curing of concrete and the use of calcium chloride in the laboratories of The Solvay Process Co.

New Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently. Copies of them can be obtained by addressing the firms mentioned:

Traffic Marking.—A method of traffic marking by means of metal "spots" is described in a circular just issued by the Bridgeport Brass Co., Bridgeport, Conn. The "spots" are brass cups inserted in the pavement, 3 in. in diameter for pedestrian lines and markings are 4½ in. in diameter for traffic divisional lines.

1-Man Power Shovel.—A specification sheet relative to its 1-Man truck loader and excavator of the Fordson crawler type has been issued by the Mandt Co., Keokuk, Iowa.

Vibrolithic Pavement.—A booklet containing illustrations and statistics of Vibrolithic pavement has been brought out by the American Vibrolithic Corp., Insurance Exchange Bldg., Des Moines, Ia. Included are testimonials from various engineers regarding their experiences with this pavement:

Snow Removal Methods.—Results of a 4-months investigation covering snow removal are given in "The Snow Removal Book," just issued by the Caterpillar Tractor Co., San Leandro, Cal. The book covers practically every important phase of the question, including work now being accomplished, organizations interested, cost of snow removal, methods of financing, activities of civic organizations, snow removal and the highway transportation industry, snow removal and the automobile, special problems in western states, drift control, methods and organization in cities, snow removal equipment and many other related subjects.

Excavators—Two new catalogs relating to its convertible excavators, have just been brought out by the Bay City Dredge Works, Bay City, Mich. Catalog No. 25 covers the Model 16-B convertible crane-excavator, which is a 5-in-1 all-steel machine, operating ¾-yd. capacity buckets. Bucket attachments include skimmer scoop, trench scoop, shovel, clamshell or dragline. The catalog illustrates the use of the machine with these different attachments on a wide range of work. Catalog No. 24 covers the smaller Model 4½-yd. capacity excavator. This machine is also convertible, and equipped with ½-yd. capacity shovel, skimmer scoop, trench scoop, dragline or clamshell. It is a smaller and lighter machine.

Air Compressors.—The Pennsylvania Pump & Compressor Co., Easton, Pa., has just issued a new bulletin No. 126, illustrating and describing Pennsylvania duplex single stage and two stage cross compound air compressors.

Industrial Notes

R. B. Sinnock has joined the Climax Engineering Co., Clinton, Ia., as a sales representative. He will make his headquarters at Clinton and will handle sales of Climax gasoline engines in the territory adjacent to that point. Mr. Sinnock was previously a member of the sales force of the Dayton-Dowd Co., Quincy, Ill. C. H. Adams has also been appointed a sales representative for the Climax Engineering Co., and will travel throughout the southeastern portion of the United States. Mr. Adams has had a wide experience in the sale of mechanical equipment throughout that territory.

Michigan Vibrolithic, Incorporated, announces the addition of O. C. Hubbard to its personnel as vice-president and manager of the company. Mr. Hubbard will have charge of the promotion and sale of "Vibrolithic" and "Interlocking" bituminous pavements in the state of Michigan, with headquarters at 1111 Kresge Bldg., Detroit, Mich. For 12 years Mr. Hubbard was with the Service Department of the Universal Portland Cement Co., operating in Illinois and Wisconsin. In 1919 he organized the Wisconsin Mineral Aggregate Association, and was active as its secretary until 1922. He then accepted a position as sales manager of the Janesville Sand & Gravel Co., Janesville, Wis., which position he left to join the "Vibrolithic" forces.

The Annual Meeting of the Eastern Paving Brick Manufacturers Association was held in New York City at the Hotel Pennsylvania Dec. 8. The day was occupied by the business meeting and all the officers were reelected for the coming year. They are as follows: President, R. L. Winslow, 41 R. 42d St., New York; Treasurer, E. T. Hutchins, Wilkes-Barre, Pa.; Secretary, W. C. Perkins, Philadelphia, Pa.; Vice-Presidents, W. W. Cunningham, Pittsburgh, Pa., F. L. Stowell, Clean, N. Y., C. C. Blair, Canton, Ohio, J. W. Hall, Baltimore, Md.; Governor, C. F. McFadden, Toronto, Ohio.; Alternate, D. R. Potter, Clarksburg, W. Va.

W. W. Sayers, formerly chief engineer of the Philadelphia plant of the Link Belt Co., has been appointed chief engineer of the company, with headquarters at 910 South Michigan Ave., Chicago. Mr. Sayers graduated from the University of Illinois in 1897 and, in his 23 years of Link-Belt experience, has successfully held many important positions in the engineering, construction and sales departments of the company. George L. Morehead, for the past 6 years attached to the management of the several Indianapolis plants, and who has made an enviable record for himself there, as well as at the Link-Belt Chicago plant, takes on the duties of manager of the Philadelphia plant. Mr. Morehead was graduated from the University of Missouri in 1902 and has been with Link-Belt Co. for the past 19 years.

Road Machinery Exhibit at Sesquicentennial Exposition.—The management of the Sesquicentennial International Exposition, to be held at Philadelphia, Pa., June 1 to Nov. 30, 1926, has set aside for the road building industry a location in the Transportation Building with ground space in close proximity for demonstrating purpose.